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Some Analyses on the Growth of Insects,
with special Reference to a Phasmid,
Phraortes kumamotoensis
Shiraki (Orthoptera)



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SOME ANALYSES ON THE GROWTH OF INSECTS,
WITH SPECIAL REFERENCE TO A PHASMID,
PHRAORTES KUMAMOTOENSIS
SHIRAKI (ORTHOPTERA)

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I. INTRODUCTION

In insects the growth is essentially a determinate process, and the size is also inherently determinate since it is the end product of growth. It is not very difficult to demonstrate the existence of a deep-seated and stable genetic constitution or the value of the constants of the relative growth function which determines size and the growth process by which it is attained in individual

insects. In other words the size may be said as the ultimate result from the interaction of a series of excitatory and inhibitory stimuli, modifiers or genetic constants of relative growth during the course of development and growth of an individual, whereby its growth follows quite closely a definite and predictable course, terminating when adult stage is attained. Further it must be noted that the termination of size growth is especially definite in the case of insects where almost without exception the imaginal or reproductive stage marks sharply the arrival of the final size and form. During the recent cycle of biological investigation much attention has been turned to the phenomenon of growth of insects. Many entomologists have attempted to analyze the growth of insects either in size or in weight, and the works in this line of research cover a great part of the literature in Entomology. Many hypotheses have been established upon several groups of insects and applied actually to detect the growth process of some injurious or non-injurious insects. Nevertheless it may seem surprising that much should be further investigated and re-examined from different points of view.

Further in studying the gradation of insect populations, especially in case of pests, economic entomologists should not forget to consider the status of parasites, the climatic environment, the reproductive powers and the food conditions. Since the primary requirement for growth is food we may expect to find that the size in insects is dependent at least to some extent upon quantity or quality of food. Vegetarian diet furnishes a much more constant and plentiful source of food material than that available for forms that depend upon animal foods, but larger amounts are necessary to supply equal energy. It should be actually necessary to take into account the quantity of food, and such consideration may be regarded as equally important or useful as those of chemical requirement of the food. Although almost every entomologist is aware of the fact that the food must play an important role on gradation in insect pests, it is nevertheless curious to see, how little study, as compared with those carried out on the effect of other factors, has yet been done in this line of investigation.

The present work has been carried out in the Entomological Laboratory of the Kyūsyū Imperial University, Hukuoka, using

a very convenient insect, *Phyaortes kumamotoensis* SHIRAKI (Orthoptera, Phasmidae), in order to fulfill some of these gaps. The aim of the former part of this paper is, firstly, to examine and record the growth of the regenerates in the course of the post-embryonic development; secondly, to note any possible variations in the growth of such regenerates from that of normal parts; thirdly, in using the records to analyze the growth of the regenerated parts, namely the growth-ratios and regeneration curves together with the laws of DYAR, PRZIBRAM and the formulae of TOKUNAGA and PAULIAN. The ultimate object is, if possible, to determine or establish norms of an ideal growth both in size and weight. The latter part of the present work is attempted, firstly, to determine the necessary amount of the food for the completion of a normal post-embryonic development and for the continuation of a normal oviposition; secondly, to establish a criterion for estimation of damage caused or will be caused by insects. For the economic entomologists the chief aim or the actual interest of the work is to prevent a calamity as early as possible and as a rule, little attention is paid by them what happens afterwards. In some cases, however, it may be necessary and useful to know some bases to estimate the losses for the future cultivation or protection of crops from injurious insects and further to know the effects of shortage of food on the gradation in the following generations of the pests. In this connection it should be stressed to remember that such theoretical prototypes as given in the present study have some limitations to its practical application already pointed out by WOODRUFF, but may serve as a guide for comparative study and a basis for quantitative consideration in the field of both theoretical and applied entomology.

II. ACKNOWLEDGMENTS

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I should like to express my sincere gratitude to Dr. Teiso ESAKI, Professor in Entomology, of the Kyūsyū Imperial University for his unchangeable and warmest encouragement, very helpful

suggestions and criticism in regard to the problems discussed in the present paper during the course of the work.

The photographs illustrating the present paper were taken by MR. Masao FUJINO of the Entomological Laboratory, Kyūsyū Imperial University, whom I express also my hearty thanks.

Finally, it is a pleasure for me to acknowledge the indefatigable cooperation of those who acted at various occasions both in rearing or examining the material and in preparing the manuscript as assistants, namely Miss Fumie NAKASHIMA, Miss Teruko SHIRAKABE and the late Miss Yukiko OHYAMA.

III. NOTES ON THE MATERIAL

The Phasmids used in the present study were from an inbred stock which has been maintained for experimental purposes in the Entomological Laboratory of the Kyūsyū Imperial University, Hukuoka. They belong to *Phraortes kumamotoensis* SHIRAKI, which is very common in Japan proper and of a convenient size for experimental use, namely the newly hatched larvae measuring 11.39–13.24 millimetres in body-length and 0.0030–0.0039 grams in weight, the adults measuring 66.5–73.8 millimetres in body-length for the male, 86.1–102.9 millimetres for the female. The newly hatched Phasmids as well as those in the following instars are very quiet in motion and may be handled quite easily by availing their cataleptic attitude when they slip to the ground, either with their appendages spread out or all packed closely parallel to the body. Such attitude facilitates the use of the material in various kinds of apparatus in weighing and transferring from one container to another. They are voracious feeders and can consume many different species of plants as food, growing rapidly to the adult stage. Those dimensions as mentioned above are attained in 65–75 days for the male, 74–90 days for the female in natural conditions. The duration of the larval stadia are summarized in the following table.

As is seen in the Table 1, a general trend that the average number of days in completing each instar decreases with age, except for the last instar in the female, is to be noted, *i.e.*, the first stadium is the longest, the fourth and fifth are almost equal

Table 1. A summary of development for *Phraortes kumamotoensis* reared in the laboratory. Figures denote the time in days.

Sex		Larval stadia						Total
		I	II	III	IV	V	VI	
♀	Maximum	29	19	14	13	13	17	90
	Minimum	21	12	11	10	9	10	74
	Average	25.3	15.4	12.2	11.6	11.0	12.9	83.4
♂	Maximum	29	18	15	12	12		75
	Minimum	23	11	11	9	8		65
	Average	25.0	14.7	13.1	11.0	11.1		71.1
Average	Maximum	29	19	15	13	13		90
	Minimum	21	11	11	9	8		65
	Average	25.2	15.1	12.6	11.3	10.5		78.1

and the shortest, and the second and third are successively longer. According to my rearing experiments of about 500 individuals, the males moult five times without exceptions while the females undergo normally six moults under natural conditions. In Hukuoka Province, the larvae hatch out early in April and reach maturity later in June or early in July. The length of life of adult females kept under natural conditions varies from three to five months. The male has a shorter life. Thus the insect has but a single generation each year. The population of the two sexes seems to be more or less equal. The females undergo a preoviposition period of about ten days. Thereafter, they drop one to ten eggs a day, the average for six females being 4.5 eggs. The number of eggs laid by a normal female is considerably variable. The results of my observations show that a single female is often capable of laying 600 eggs or even more but whether they lay this number of eggs under field conditions is questionable. The eggs dropped by the females were kept in paper or wooden boxes, placed in the room until the next spring under natural conditions and passed the winter, and no moisture control was provided. The incubation period varies from 150 to 250 days, thus covering an extreme range of about 200 days. Only a small percentage (28.6 per cent) of larvae are able to complete the hatching from

the eggs, and therefore a large number of eggs were needed for my experimental study. The range of temperature of the laboratory during the post-embryonic development of the material was between 15° and 23°C, and those of relative humidity was between 70 and 85 per cent. This range of temperature, though great, is believed not to have unduly affected the results of this study, as the object of the present investigation lies on the line of the normal growth of the insects under field or natural conditions, and often analyses of the experimented data were carried out under consideration of eliminating the time factors. The results of rearing experiments made in various relative humidities have shown that the optimum relative humidities lie between 65 and 90 per cent, and when the relative humidities are below 50 per cent or in water-saturated conditions the material cannot continue its normal development. Further detailed accounts of the material may be seen in my earlier papers (1930-1933).

IV. GROWTH IN LENGTH

A. Growth in Absolute Length

Percentage increase in length in each instar. The percentage increase (α) in length (or width) in each instar was calculated by the following formula

$$\alpha = \frac{L_{n+1} - L_n}{L_n} \times 100,$$

where L_n designates the length of a part in the instar n . The values are shown in the Table 4 and the following results were obtained.

1. In the second instar the highest values of α are found in the lengths of the pronotum, the mesonotum, the metanotum, the total length of the thorax, the antennae (φ), the fore femur, the fore tibia (φ), the mid-femur, the mid-tibia, the hind femur and of the hind tibia (φ).

2. In the third instar the highest values of α are observed in the length of the head (δ), the total length of the body and in the width of the head.

3. In the fourth instar the value of α in the length of the abdomen is the highest.

4. In the sixth instar the α takes the highest value in the lengths of the antenna (δ), the head (φ), the fore tibia (δ) and of the hind tibia (δ).

5. In the last instar the values of α in such items as the length and width of the head, the lengths of the pronotum, the abdomen and of the total body of the male sex are always lower than those in the female sex.

6. The curves showing the percentage increase in width of the head throughout the post-embryonic developmental period are similar to those of the length of the abdomen. The curves of the same of such parts as the whole thorax, the metanotum only, the femur and the tarsus show the same feature.

7. The sex differentiation in the rates of increase was emphasized in the following order: the length of the hind femur, the length of the antenna and of the fore tibia, the length of the fore femur, the length of the mid-femur, the length of the head and of the mid-tibia, the length of the pronotum, the length of the mesonotum, the total length of the thorax, the width of the head and the length of the hind tibia, the total length of the body and finally the length of the metanotum.

Percentage length of the allometric organs during the post-embryonic developmental period. The percentage length (β) of any allometric organs in each instar was calculated by the following formula

$$\beta = \frac{\text{Length of the part in the instar } n}{\text{Ultimate length of the part}} \times 100,$$

and the results are shown in the Table 5 given below.

From this table we can definitely see the following facts. In the appendages β takes the value of 50 per cent in the fourth instar. In the allometric organs (except for the appendages) of the female β secures the value of 50 per cent also in the fourth instar, while in the male β attains the value of 50 per cent as early as in the third instar.

Change of the partial indices of the allometric organs during the post-embryonic developmental period. The partial index (γ) of any allometric organ was calculated by the following formula

$$\gamma = \frac{\text{Length of the allometric organ}}{\text{Total length of the body}} \times 100.$$

The results obtained are given in the Table 6.

Table 2. Average length (or width) of different parts in *Phraortes kumamotoensis* larvae at different instars of growth. In millimetres.

Instar	Head			Thorax					Abdomen				Body	
	Length	Width	Antenna	Pronotum	Mesonotum	Metanotum	Total length	Fore leg		Mid-leg		Hind leg		
								Femur	Tibia	Femur	Tibia	Femur		Tibia
I	1.2	1.0	7.7	6.9	3.2	2.6	8.1	3.4	3.2	2.8	2.8	3.9	3.6	18.7
II	1.4	1.3	11.4	1.2	4.7	3.0	9.0	5.5	4.8	4.3	4.2	4.8	5.2	23.5
III	1.9	1.7	16.1	1.5	6.5	4.3	12.4	7.8	7.1	5.9	5.0	6.4	7.3	33.6
IV	2.4	2.2	22.7	1.9	8.8	5.6	16.4	10.5	9.7	7.8	8.1	8.9	9.6	44.7
V	2.9	2.8	33.7	2.4	11.7	7.3	22.3	15.0	14.8	11.0	11.1	12.5	13.2	34.1
VI	3.5	3.1	54.3	2.7	15.6	9.9	28.8	21.0	22.8	16.0	16.0	18.6	20.2	39.7
VII	4.0	3.4	38.0	3.0	14.5	9.6	24.5	16.7	15.9	12.7	12.2	14.1	14.6	42.8
VII	4.9	4.1	51.1	3.6	18.7	12.0	34.5	21.9	21.7	16.5	15.4	18.7	19.2	54.1

* VI and VII represent male and female adults respectively.

Table 3. Average increase in length (or width) of different parts in *Phaortes kumamotoensis* larvae in successive instars of growth. In millimetres.

Instar	Head			Thorax										Abdomen	Body
	Length	Width	Antenna	Pronotum			Total length	Fore leg		Mid-leg		Hind leg			
				Mesonotum	Metanotum	Femur		Tibia	Femur	Tibia	Femur	Tibia			
I- II	0.2	0.3	3.7	0.3	1.5	1.0	2.9	2.1	1.6	1.5	1.4	1.8	1.7	3.2	4.9
II- III	0.5	0.4	4.7	0.3	1.8	1.3	3.4	2.3	2.3	1.6	1.8	1.8	2.1	4.8	10.1
III- IV	0.5	0.5	6.6	0.4	2.3	1.3	4.0	2.7	2.6	1.9	2.1	2.3	2.2	6.5	11.1
IV- V	0.5	0.6	$\left\{ \begin{array}{l} \delta 11.0 \\ \varphi 6.2 \end{array} \right.$	0.5	2.9	2.2	5.9	4.5	5.1	3.2	3.0	3.6	3.7	8.3	14.7
								2.8	3.0	2.1	1.9	1.8	3.2		
V- VI	$\left\{ \begin{array}{l} \delta 0.6 \\ \varphi 1.1 \end{array} \right.$	0.3	20.6	0.3	3.9	2.1	6.5	6.0	8.0	5.0	4.9	6.1	7.0	5.6	11.9
								3.4	3.2	2.8	2.2	3.4	1.9		
VI- VII	0.9	0.7	13.1	0.6	4.2	2.4	10.0	5.2	5.8	3.8	3.2	4.6	4.8	11.3	19.5

Table 4. Percentage increase in length of different parts in
Phraortes kumamotoensis at different instars of growth.

Instar	Head			Thorax								Abdomen		Body		
	Length	Width	Antenna	Pronotum	Mesonotum	Metanotum	Total length	Fore leg		Mid-leg					Hind leg	
								Femur	Tibia	Femur	Tibia				Femur	Tibia
I- II	16.6	30.0	48.0	33.3	46.8	50.0	47.5	61.7	50.0	53.5	50.0	60.0	48.5	28.3	28.5	
II- III	35.7	30.7	41.2	25.0	38.2	43.3	37.7	41.8	47.9	37.2	42.8	37.5	40.3	33.1	42.9	
III- IV	26.3	29.4	40.9	26.6	35.3	30.3	32.2	34.6	36.6	32.2	35.0	34.8	30.1	33.5	38.5	
IV- V	20.8	27.2	$\left\{ \begin{array}{l} 548.4 \\ 27.3 \end{array} \right.$	26.3	32.9	39.2	35.9	42.8	52.5	41.0	37.0	40.4	38.9	32.1	32.8	
V- IV	$\left\{ \begin{array}{l} 20.6 \\ 37.9 \end{array} \right.$	10.7	61.1	12.5	33.3	26.9	29.1	40.0	54.0	45.4	44.1	48.8	53.0	16.4	22.0	
VI- VII	22.5	20.5	34.4	20.0	28.9	25.0	40.8	31.1	36.4	29.9	26.2	32.5	32.8	26.4	26.3	

Table 6. Partial indices of the allometric organs of
Phraortes kumamotoensis SHIRAKI during the instars.

Instar	Head length	Head width	Pronotum length	Mesonotum length	Metanotum length	Thorax length	Abdomen length
I	6.4	5.7	5.7	17.1	10.8	32.8	60.6
II	6.1	5.8	5.1	20.0	12.9	38.5	61.6
III	5.6	5.1	4.4	19.3	12.8	36.9	57.4
IV	5.5	4.9	4.2	19.6	12.7	36.8	57.3
V	4.9	4.6	3.9	19.6	13.2	37.4	57.4
VI	♂ 4.5	4.3	3.7	21.8	13.8	39.5	55.3
	♀ 5.2	4.6	4.1	19.5	13.0	36.8	57.6
VII	5.2	4.3	4.0	19.8	12.7	36.7	57.5

Instar	Antenna length	Fore femur length	Fore tibia length	Mid- femur length	Mid- tibia length	Hind femur length	Hind tibia length
I	41.3	19.9	18.4	16.1	16.4	17.6	20.1
II	48.5	22.8	20.5	18.5	17.5	20.4	22.3
III	47.9	23.2	21.2	17.7	17.8	19.8	21.6
IV	50.6	23.1	21.7	18.0	16.0	19.9	21.2
V	♂ 55.6	24.7	24.3	18.1	18.4	20.5	21.7
	♀ 49.6	22.8	21.8	17.0	17.0	19.1	20.6
VI	♂ 76.4	29.3	31.9	22.4	22.9	25.4	28.3
	♀ 51.2	22.5	21.4	17.1	16.5	19.0	19.9
VII	52.7	23.2	23.1	17.5	16.7	19.9	20.8

In careful observations on the data given above the following conclusions may be derived.

1. The value of γ of the head length undergoes a very gradual reduction from the first instar to the adult stage. From the fourth instar the value of γ of the head length in the female shows no change, thus the curve indicating the change of the value of γ with the instars of the same sex may be represented by two straight lines. This fact means that in the three later instars the rates of increase in lengths of the head and of the body are entirely the same as each other. On the contrary the value of γ of the head length in the male decreases steadily in the successive instars. Therefore the curve indicating the change of the value of γ with the ages may be represented by a single straight line.

2. The value of γ of the head width decreases more steadily in the successive instars. The behaviour of the values in the increase of the width of the head may be shown by a single straight line.

3. The value of γ of the pronotum length undergoes a reduction in the earlier instars. The behaviour of the values of γ is quite similar to those of the head length of the female sex.

4. The value of γ of the length of the mesonotum shows a tendency to rise prominently in the second instar, which is followed by a constancy in the female sex and by a marked increase again in the sixth instar in the male sex. Thus the curve indicating the change of the value of γ of the mesonotum length with the instars may be represented by two straight lines in the female and three in the male.

5. The behaviour of the values of γ of the metanotum length is very much similar to that of the mesonotum.

6. The behaviour of the values of γ of the total length of the thorax is also similar to that in the above case. But in this case the value of γ of the thorax length shows a tendency to decrease prominently in the third instar.

7. The value of γ of the length of the abdomen increases steadily in the second instar which is followed by a steep decrease in the third instar, then keeps practically constant value from the third instar to the adult stage in the female. In the male the value of γ decreases prominently from the fifth instar to the adult stage or the relative increase in length of the abdomen is notably smaller in the instar in question. This fact has a close connection with the high value of γ of the lengths of the male appendages from the fifth instar to the adult stage.

8. The behaviour of the value of γ of the length of the female antenna is similar to those of the fore femur and of the fore tibia in the same sex. In the second instar the value increases prominently. The value of γ of the length of the femur in the female keeps almost constant through the following instars. The value of γ of the length of the female antenna shows a tendency to rise very much slowly in the following instars while those of the fore tibia shows a marked increase in the same instars.

9. The value of γ of the length of the mid-femur increases

markedly in the second instar which is followed by a gradual decrease up to the fifth instar, then further followed by a slight increase from the next instar. The behaviour of the values of γ of the lengths of the hind femur and tarsus is as follows: in the second instar the value increases markedly, from the third to the sixth instars the value decreases steadily, and in the seventh instar the value increases again though very slightly. The value of γ of the length of the mid-tibia increases more or less in the second, third and the fifth instars and decreases in the fourth and the sixth instars. In the seventh instar the value keeps constant.

10. The curve indicating the change of the value of γ of the lengths of the female antenna, fore tibia and fore femur with the instars may be represented by two straight lines. The curve showing the change of the value of γ of the lengths of the female mid-tibia, mid-femur, hind tibia and hind femur may be divided into three straight lines.

11. The value of γ of the lengths of the male appendages shows a marked increase in the sixth instar. Thus the curve indicating the change of the value of γ with the instars may be shown by four straight lines.

12. Generally speaking the values of γ show a tendency to fix themselves constant much earlier in the female than in the male, and this statement coincides very well with the results obtained in the case of the relative growth.

B. Relative Growth

In 1932 J. HUXLEY has produced an exponential formula which expresses by means of an abstract value the rate of growth of any one of allometric organs in relation to that of another organ whose growth is taken as a standard. Using his method we may be able to compare the rates of development of several parts and to investigate the intensity of growth which is characterized by the growth-gradients. I applied the formula established by HUXLEY to the data shown in Tables 2-3 in order to analyze the characteristics of the growth in length of several allometric organs measured in *Phraortes kumamotoensis* SHIRAKI. Taking the total length of the body as the standard growing organ (x), and the head, pronotum, mesonotum, metanotum, antenna, fore femur, fore

tibia, mid-femur, mid-tibia, hind femur, hind tibia and abdomen as the differential growing parts (y), I fitted the data into the expression $y=bx^a$ (from this formula is derived: $\log y=\log b+a \log x$; this means that if the logarithms of the magnitudes are plotted, we should expect a straight line, from the slope of which the value of a or the constant differential growth-ratio can be read off), which expresses logarithmically the relations between the body and the differential growing parts. Thus using the formula and assigning to x and y their corresponding values up to the adult stage, a series of results were secured and classified into several growth-phases. These were summarized in the following table.

Table 7. Values of a obtainable during the post-embryonic growth of *Phraortes kumamotoensis* SHIRAKI.

Sex	y	a			
		Phase I	Phase II	Phase III	Phase IV
♂	Head length	0.76	0.76	0.76	0.76
	Head width	0.85	0.62	0.62	0.62
	Pronotum length	1.09	1.00	0.62	0.62
	Mesonotum length	1.54	1.00	1.62	1.62
	Metanotum length	1.54	1.00	1.25	1.25
	Antenna length	1.54	1.08	1.41	2.62
	Fore femur length	1.90	1.00	1.25	1.87
	Fore tibia length	1.63	1.08	1.58	2.25
	Mid-femur length	1.72	0.96	1.25	2.00
	Mid-tibia length	1.63	0.93	1.16	2.00
	Hind femur length	1.90	0.98	1.25	2.12
	Hind tibia length	1.50	0.95	1.25	2.25
♀	Abdomen length	0.95	0.75	0.75	0.75
	Head length	0.76	0.76	1.55	0.81
	Head width	0.85	0.85	0.85	0.85
	Pronotum length	1.09	1.00	1.00	1.00
	Mesonotum length	1.54	1.00	1.00	1.00
	Metanotum length	1.54	1.00	1.00	1.00
	Antenna length	1.54	1.08	1.08	1.08
	Fore femur length	1.90	1.00	1.00	1.00
	Fore tibia length	1.63	1.08	1.08	1.08
	Mid-femur length	1.72	0.96	0.96	0.96
	Mid-tibia length	1.63	0.93	0.93	0.93
	Hind femur length	1.90	0.98	0.98	0.98
	Hind tibia length	1.50	0.95	0.95	0.95
	Abdomen length	0.95	0.95	0.95	0.95

1. The female insects generally exhibit two phases in the relative growth, while the males have one to three phases in the growth according to the different parts on the body-axis and four phases in the growth of the appendages.

2. In the male the head length shows a marked negative allometry with the growth coefficient 0.76 throughout the instars. In the female the relative increase in length of the head is divided into three phases, *i.e.* the first phase lasts during the four earlier instars, showing a marked negative allometry, the second phase is seen in the fifth instar indicating the value of α with a marked positive allometry, and the third phase shows a marked negative allometry in the sixth instar.

3. In the female the relative increase in the width of head shows a marked negative allometry with the growth coefficient 0.85 throughout the instars. A fall in the second instar occurs in the male, after which the value of α is constant until the adult stage.

4. The pronotum is characterized by its almost isometric growth. In the male a marked fall occurs in the fifth instar.

5. The mesonotum is a highly positive allometric part in the first instar in both sexes. After the second instar the mesonotum is characterized by its isometric growth throughout all the instars up to the adult in the female, while it attains its former value in the fifth instar (third phase) in the male.

6. The relative increase in length of the metanotum is almost similar to those of the mesonotum.

7. In the male the relative growth of the appendages may be represented by four phases. The first phase (the first instar) is characterized by a marked positive allometric growth. With increase in absolute size the velocity of growth of the appendages in length increases during the instars second to fifth. Therefore the allometry varies from isometric to highly positive.

8. In the female the relative growth of the appendages may be represented by only two phases. In the first instar the growth coefficient takes the value of highly positive. A fall takes place in the second instar, after which the value of α is constant and the growth is almost isometric until the adult stage.

9. A higher variation in the intensity of allometry of any of

the appendages between the sexes seems to initiate in the fourth instar.

10. The abdomen is also characterized by its almost isometric growth. In the male a slight fall occurs in the fifth instar.

In 1931 HUXLEY studied the relative growth of a stag-beetle, *Lucanus cervus*, and demonstrated that in this beetle the growth-gradient slopes down from the head to the hind legs, with the highest values in the mandibles, and between the first and second pair of legs the allometry changes from positive to negative. In 1934 DIXEY and GARDINER analyzed the allometric growth of an ant, *Messor barbarus*, and gave the following conclusions. In this ant the growth-gradient slopes down in an antero-posterior direction with a high value growth-centre localized in the head, and the gradient reaches a negative value in the last pair of legs. In 1938 I investigated the allometry of an ichneumon-fly, *Thalessa citraria* (♂), and found the following facts. Contrary to all the known cases of the allometry in insects, this ichneumon-fly has a high allometry-coefficient posteriorly and a postero-anterior gradient in the distribution of growth potential in other parts of the body. Correlated with positive allometry of the abdomen, in which the growth-centre seems to exist, the length of the hind leg shows a slight positive allometry. In the legs, there exists a distinct but slight growth-gradient sloping down centripetally. In the same year DUARTE published the results of his study on the allometry of a locust, *Locusta migratoria*. According to DUARTE the following three distinct features characterize the growth-gradients in this insect. The gradient rises steeply from a negative value in the head to a high positive value in some part of the pronotum, and falls to a negative value in the hind legs. Therefore the growth centre is localized in the zone of the pronotum. Generally with the increase of the insect in size the relative growth-ratio decreases correspondingly. The fall is more conspicuous in the middle (pronotum) than in the extremities. The most extreme variation is shown by the pronotum as against the little variation in the head. The decrease in intensity of the growth-centre is greater in the fifth-adult instar than in the previous instars. The third feature of the gradient is the reverse variation of the growth of the most posterior portions, viz., the hind femur, as if the curve was rotating round the middle femur in an anti-clockwise direc-

tion. This feature is more marked in gregarious forms than in the solitary.

In the case of *Phraortes kumamotoensis* SHIRAKI the features of the growth-gradients are quite different from any of the known cases given above and very much complicated.

11. In the first phase of allometry of the female sex, there exists a highly positive growth-centre in the regions of meso- and metathorax from where very steep growth-gradients are graded down both anteriorly and posteriorly along the main axis of the body. There is a high growth-gradient graded down proximally in the antennae. In the legs there is found a definite high growth-centre in the femoral region from where strong positive growth-gradients are graded both in centrifugal and centripetal directions.

12. In the second phase of allometry of the female sex, the growth of the thorax as well as the fore femur become completely isometric. The abdomen undergoes a low negative allometry. The head is a negative growth-centre along the main axis of the body. In the fore legs there exists a centripetal growth-gradient in the tibial region. In both the mid- and hind legs there is a centrifugal growth-gradient both in the femoral and tibial regions.

13. Meanwhile the head represents a high positive growth-centre only in the fifth instar, when very steep growth-gradients are sloping down from the head to the antennae and the pronotum.

14. In both the first and second phases of allometry of the male sex, the distribution of the growth-potential along the main axis of the body is quite similar to those of the female.

15. In the third phase of allometry of the male sex, the mesonotum becomes a high positive growth-centre from where steep positive gradients are sloping down both anteriorly and posteriorly. In the head region there exists a low growth-gradient sloping down towards the pronotum. A very steep growth-gradient is sloping down posteriorly from the metathorax to the abdomen. There exists a centripetal growth-gradient in the fore legs and a centrifugal one in the mid-legs. In the hind legs the value of the growth-partition coefficient of the femur is the same as those of the tibia as well as the metathorax.

16. In the fourth phase of allometry of the male sex, the distribution of the growth-potential along the main axis of the

body is similar to that of the third phase. As in the third phase there exists a definite growth-gradient sloping down proximally

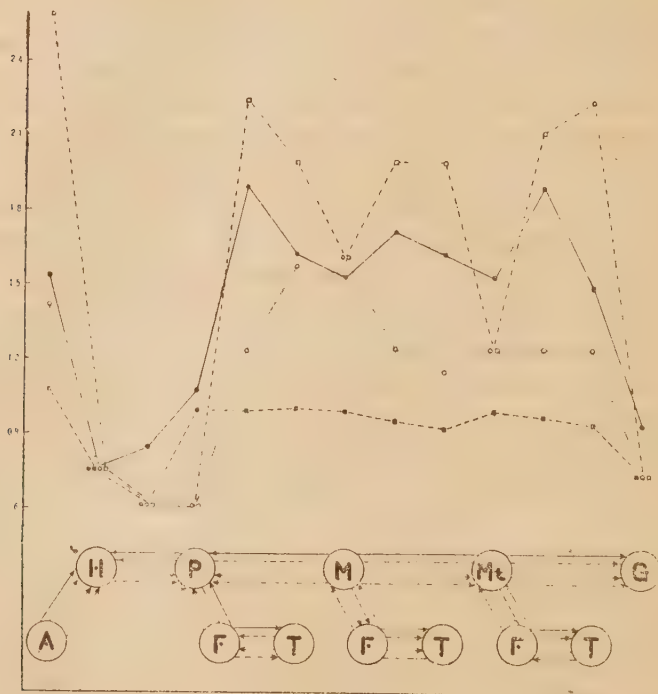


Fig. 1. Change of growth-gradient in the body of *Phraortes kumamotoensis* (δ). The abscissa axis represents the antero-posterior axis of the body. The ordinate axis represents the α value. A: antenna H: head P: pronotum F: femur T: tibia M: mesothorax Mt: metathorax G: abdomen ●: 1st phase ■: 2nd phase ○: 3rd phase □: 4th phase.

with a very high positive growth-centre in the antennae. In the fore legs there exists a definite growth-centre in the femoral region, from where strong positive growth-gradients are graded both in centripetal and centrifugal directions. In the mid-legs both the femur and tibia take the same value of a very high growth-partition coefficient and there exists a centripetal growth-gradient in the femur. In the hind legs a steep growth-gradient is graded centripetally and the tibia becomes a high positive growth-centre.

17. Generally with the increase of the insect in size the

relative growth-ratios of the antenna, thorax and all legs decrease correspondingly. The fall is prominent in such an order as follows: the hind femur, fore femur, mid-femur, mid-tibia, fore tibia, mesothorax, metathorax, hind tibia and the antenna.

18. From the third growth-phase of the male the relative growth-ratios of the antennae and all legs increase correspondingly with the growth of the insect in size. The rise is prominent in such an order as: the antenna, hind tibia, fore femur, hind femur, mid-tibia, mid-femur and fore tibia.

19. In the male pronotum the relative growth-ratio decreases in the third phase and does not change its value in the next phase.

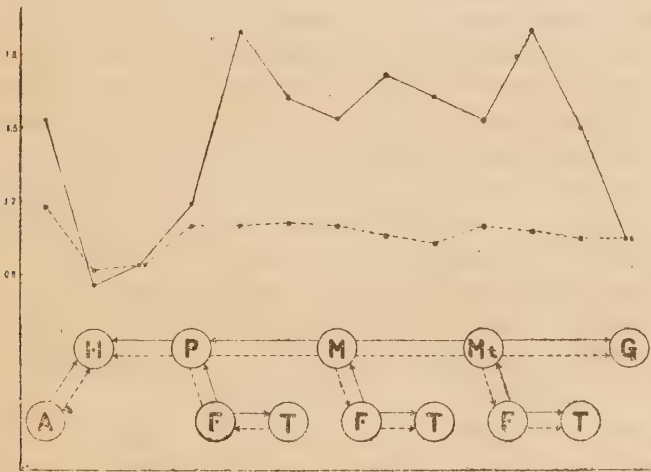


Fig. 2. Change of growth-gradient in the body of *Phraortes kumamotoensis* (♀).
The abscissa and ordinate as in Fig 1. ● : 1st phase ■ : 2nd phase.

20. In the male meso- and metathorax the relative growth-ratio increases conspicuously in the third phase and does not alter its value in the next phase. The rise is more conspicuous in the mesothorax than in the metathorax.

21. In the male abdomen the relative growth-ratio decreases slightly in the second phase, and then increases very slightly in the following phases with the increase of the insect in size correspondingly.

22. The increase or decrease in intensity of the growth-centre along the main axis of the body is greater in value in the second-third phase than in the first-second phase. The most extreme variation in intensity of the growth-centre along the main axis of the body is shown by the mesothorax or metathorax as against the little variation in the head or abdomen.

C. Regeneration Experiments

Material and Methods

In the present series of experiments on the growth of *Phraortes kumamotoensis* SHIRAKI, more than three hundred individuals were used, and *Lyonia Neziki* was used as food rearing the material. The observations were carefully made on insects isolated from the first instar one each in a separate rearing box. In all cases the insects were fed on plentiful food. Extensive biometrical works were begun from the first instar and covered all the instars up to the adult. The measurements were made in each case after the insect had moulted and the cuticle had acquired the usual degree of rigidity. The parts of the larvae in the first instar were measured under a microscope fitted with a micrometer eye-piece. When the parts became too large to be measured under an ordinary microscope, a binocular microscope fitted with a micrometer eye-piece was used.

Measurements were made on the following parts:

1. Length of body (B)
2. Length of mesonotum (M)
3. Length of metanotum (P)
4. Length of fore femur (F)
5. Length of fore tibia (FT)
6. Length of mid-femur (MF)
7. Length of mid-tibia (MT)
8. Length of hind femur (HF)
9. Length of hind tibia (HT)
10. Length of tarsus

In all cases the length of the mesonotum was taken as the standard growing organ (x), and the length of the femur, tibia and tarsus as the differential growing parts (y). By using the allometric formula $y=bx^a$, the constant differential growth-ratios of allometric organs were calculated, and the logarithms of the measurements were plotted graphically.

The legs of the material are very responsible for autotomy by a sudden stimulus. The autotomy of this species occurs at the trochantero-femoral suture as in all members of the family Phasmidae. This character of autotomy was utilized in the present investigation. Further it was needed to amputate the legs at any point and at any time. The amputations were made by means of a pair of fine scissors. In order to keep the insects quiet and to prevent the autotomy, this operation was performed with the larvae which were anesthetized with ether, otherwise it was very difficult or almost impossible to cut off the parts of the legs at any desired point.

The experiments were classified in the following groups.
Experiments class 1 : Operation of one fore leg in the first instar.

Twenty individuals just after hatching were selected for experimentation.

Experiments class 2 : Operation of one fore leg in the second instar. Ten individuals just after the first moult were used for this purpose.

Experiments class 3 : Operation of one fore leg in the third instar. Ten individuals just after the second moult were used.

Experiments class 4 : Operation of one fore leg in the fourth instar. Ten individuals just after the third moult were used.

Experiments class 5 : Operation of one mid-leg in the first instar. Twenty individuals just after hatching were selected.

Experiments class 6 : Operation of one mid-leg in the second instar. Ten individuals just after the first moult were used.

Experiments class 7 : Operation of one mid-leg in the third instar. Ten individuals just after the second moult were used.

Experiments class 8 : Operation of one mid-leg in the fourth instar. Eight individuals just after the third moult were used.

Experiments class 9 : Operation of one mid-leg in the fifth instar. Five individuals just after the fourth moult were selected.

Experiments class 10 : Operation of one hind leg in the first instar. Twenty individuals just after hatching were used.

Experiments class 11 : Operation of one hind leg in the second instar. Thirteen individuals just after the first moult were used.

Experiments class 12 : Operation of one hind leg in the third instar. Twenty individuals just after the second moult were selected.

Experiments class 13 : Operation of one hind leg in the fourth instar. Ten individuals just after the third moult were used.

Experiments class 14 : Operation of one hind leg in the fifth instar. Eight individuals just after the fourth moult were used.

Experiments class 15 : Operation of two fore legs. Four individuals were used.

Experiments class 16 : Operation of two mid-legs. Ten individuals were selected.

Experiments class 17 : Operation of two hind legs. Twenty individuals were used.

Experiments class 18 : Simultaneous operations of two or three different series of legs. Twenty individuals were used.

Experiments class 19 : Successive operations of two or more legs of different series. Sixty individuals were selected.

D. Descriptions of the Results.

1. Experiments Series 1

Experiments Class 1

No. 1. The right-hand fore leg of a newly hatched larva was removed by amputation from the trochantero-femoral suture. This individual died just after the second ecdysis. The values of α for the growth of the regenerate were 3.61 for the tibia and 2.46 for the femur.

No. 2. The left-hand fore leg of a newly hatched female larva was removed by amputation from the trochantero-femoral suture. This individual lost its left-hand mid-leg by autotomy. The values of α for the growth of the fore regenerate were suc-

cessively 2.88 and 1.00 for the tibia and 0.88 and 1.90 for the femur during the two last larval instars respectively. The values of α for the growth of the mid-regenerate were 2.00 and 1.20 for the tibia and 2.00 and 1.30 for the femur during the same instar.

No. 23 Distal 1.75 mm of the right-hand fore tibia of a newly hatched male larva was removed by amputation. The operated tibia continued to grow during the course of the larval development and reached 17.5 mm in length in the last larval instar which was 1 mm shorter than the unamputated tibia of the opposite side. It was apparently demonstrated in this experiment that the growth of the fore femur with an amputated tibia was obviously checked by the regeneration of the lost parts and reached 18.5 mm in length (2 mm shorter than the opposite femur with the normal tibia) after the last ecdysis. Further it must be noted that the values of α for the growth of the regenerate tibia were increased 0.72, 2.20 and 2.42 successively. The differentiation of the segmentation in the regenerate tarsus appeared externally after the second ecdysis. The total length of the regenerate tarsus in succeeding instars were 0.7 mm (third instar), 3.50 mm (fifth instar) and 4.75 mm (sixth instar) respectively. The length of the regenerate tarsal segments attained 2.0 mm (1st segment) and 1.5 mm (2+3+4 segments) in the preadult instar and 3.0 mm (1st segment) and 1.75 mm (2+3+4 segments) just after the final ecdysis respectively. Here it is evident that the value of α for the growth of the regenerate first tarsal segment is larger than that of the distal segments.

No. 40 The right-hand fore leg of a newly hatched female larva was removed by amputation from the trochantero-femoral suture. The observation was stopped at the sixth instar, as the regenerated leg was lost by autotomy after the sixth ecdysis. The values of α for the growth of the regenerate were decreasing in successive instars. The differentiation of the segmentation in the regenerate tarsus took place externally after the second ecdysis. The total length of the regenerate tarsus in succeeding instars was 0.7 mm (third instar), 2.1 mm (fifth instar) and 4.0 mm (sixth instar) respectively. The values of α for the growth of the regenerate first tarsal segment were larger than that of the regenerate distal tarsal segments as in the experiment No. 23.

No. 282 Distal 0.9 mm of the right-hand fore femur of a newly hatched male larva was removed by amputation. The wounded femur decreased in length at first, being 2.0 mm after the first ecdysis and 1.2 mm after the second one and then became 2.6 mm (still 0.1 mm shorter than in the first instar) after the third ecdysis. It is very clear that in this case the growth of the wounded femur was strikingly checked by the reconstruction or regeneration of the lost apical part of femur, entire tibia and tarsus. After the second ecdysis the femur increased in length very much. The bud of the tibia and tarsus did not appear externally in the second instar, but became observable as a small but distinct segment after the second ecdysis. The bud of the tarsus appeared separately after the third ecdysis. The values of α for the growth of the wounded femur for successive instars were -0.76 , -1.29 , 3.09 , 5.00 and 2.66 respectively. The last two values of α would indicate the existence of a regulation power within the regenerate itself.

No. 283 Distal 1.0 mm of the right-hand fore femur of a newly hatched male larva was removed by amputation. The wounded femur decreased in length from ecdysis to ecdysis at first, being 1.9 mm after the first ecdysis and 1.5 mm after the second one. The bud of the regenerate tibia and tarsus appeared externally in the third instar. In this case, too, the growth of the wounded femur was apparently influenced by the reconstruction of the lost parts. The values of α for the growth of the wounded femur for successive instars were -1.06 , -0.62 , 6.40 , 0.27 and 3.85 respectively. The growth of the regenerate was regulated twice during its larval developmental stages. The reason of the appearance of the second regulation force in the fourth instar is not clear.

No. 284 Distal 1.7 mm of the left-hand fore femur of a newly hatched male larva was removed by amputation. The wounded femur decreased in length ecdysis after ecdysis, being 1.8 mm after the first ecdysis and 1.5 mm after the second one. The bud of the regenerate tibia appeared after the second ecdysis, and that of the tarsus was observed after the third ecdysis. In this case, too, the growth of the wounded femur was prominently checked by the regeneration of the lost parts.

No. 285 Distal 1.6 mm of the left-hand fore femur of a

newly hatched female larva was removed by amputation. The wounded femur decreased in length ecdysis after ecdysis at first, being 0.25 mm (one-eighth the length of the remaining part of the femur at the operation) after the first ecdysis and 1.0 mm, 1.0 mm and 1.5 mm after respective ecdyses. This fact demonstrates clearly that the growth of the wounded femur was very much checked by the reconstruction of the lost parts, or, in other words, there was needed a great quantity of energy to regenerate the lost part of the femur, entire tibia and tarsus. Consequently the external appearance of the bud of the tibia was exceedingly delayed as late as in the fifth instar. The bud of the tarsus appeared after the fifth ecdysis.

No. 289 Distal 0.5 mm length of the right-hand fore femur of a newly hatched larva was removed by amputation. The wounded femur gently reconstructed the lost parts ecdysis after ecdysis, being 4.0 mm after the first ecdysis and 4.5 mm after the second one. But the bud of the tibia and tarsus never appeared even in the third instar when death occurred.

No. 292 Distal 2.5 mm of the right-hand fore femur of a newly hatched male larva was removed by amputation. The growth of the wounded femur was apparently influenced by the regeneration of the lost parts and decreased in length in the two earlier instars, being 1.0 mm after the first ecdysis and 0.9 mm after the second one. The bud of the regenerate tibia and tarsus was first appeared just after the third moult.

No. 293 Distal 1.5 mm of the left-hand fore femur of a newly hatched female larva was cut. This individual died after the sixth ecdysis by an unknown cause. The growth of the wounded femur was very much influenced and delayed by the reconstruction of the lost parts. The length of the wounded femur decreased from ecdysis to ecdysis at first, being 2.0 mm after the first ecdysis, 1.6 mm after the second one and 1.7 mm after the third one. The bud of the regenerate tibia and tarsus appeared externally after the fourth ecdysis.

Experiments Class 2

No. 57 Distal 0.4 mm of the left-hand fore femur of a larva just after the first ecdysis was cut. This individual dropped

its regenerate in the adult stage without being measured and died. The growth of the wounded femur was very much affected by the reconstruction of the lost parts, and the values of α for it for successive instars were -0.80 , 0.90 , 0.00 and 0.30 respectively, all representing the negative allometric growth. The bud of the regenerate tibia appeared after the third ecdysis, and that of the regenerate tarsus was seen in the fifth instar. The value of α of the initial growth for the regenerate tibia was normal and very high. The regenerate tarsus was not tetramerous but composed of five segments and 0.75 mm in total length; the basal segment was 0.25 mm in length, and as long as the fourth, or as long as the second and third taken together, the second was as long as the third and the fifth was about one half as long as the basal one. After the next moult, the basal segment of the tarsus became 0.5 mm in length but the remaining segments were etiolated.

No. 58 The right-hand fore tibia of a male larva just after the first ecdysis was removed from the base. The growth of the fore femur without tibia was slightly but apparently affected and checked by the reconstruction of the distal segments. Therefore the values of α for the growth of the femur in question were 1.27 for the initial phase (1.36 for the control femur) and 0.66 for the second phase (1.11 for the control femur). In the adult stage the femur in question was 1.2 mm shorter than the control of the opposite side. The bud of the regenerate parts appeared just after the second ecdysis, and the parts were differentiated during the third instar. The growth of the regenerate tibia was very rapid, values of α being 5.63 , 4.61 and 8.80 for successive phases respectively. The growth of the regenerate basal tarsal segment was strikingly checked after the fourth ecdysis.

No. 76 Distal 2.6 mm of the right-hand fore tibia of a female larva just after the first ecdysis was removed by amputation. This individual died after the fifth ecdysis. The growth of the wounded tibia was checked after the operation by the regeneration of its lost parts. It must be noted that the growth of the femur with the wounded tibia was not at all affected by the reconstruction of the lost part of the tibia and the entire tarsus. The bud of the regenerate parts appeared after the second ecdysis. The regenerated part of the tibia was narrower than the basal part. As in the usual cases, the value of α for the growth

of the regenerate basal tarsal segment was larger than that of the remaining parts of the tarsus. In the fourth instar the basal segment of the regenerate tarsus was shorter than the remaining, while in the next instar the relation became reversed.

No. 12 Distal 1.45 mm of the right-hand fore femur of a newly hatched male larva was cut by amputation. The growth of the wounded femur was pronouncedly affected or checked by the reconstruction of the lost parts, and the values of α for the growth of it for successive instars were -0.64 , 0.80 , 2.09 , 2.83 and 2.16 respectively. The regenerate tibia appeared just after the second ecdysis and was bluish green in colour, measuring 0.5 mm in length. It is also apparent from this experiment that the growth of the regenerate tibia was at first checked by the reconstruction of the tarsus. The length of the regenerate tibia still remained 0.5 mm in the fourth instar. The values of α for the growth of the regenerate tibia were 5.83 and 3.61 in the two later phases. The bud of the regenerate tarsus appeared after the fourth ecdysis. The differentiation of the segments occurred in the fifth instar, and after the last ecdysis three-segmented tarsus appeared. The length of the tarsus was 0.75 mm, and the third segment was longer than the two basal ones taken together.

Experiments Class 3

No. 13 Distal 1.8 mm of the left-hand fore femur of a newly hatched female larva was removed by amputation. The growth of the wounded femur was distinctly checked by the reconstruction of the lost parts. The values of α for the growth of the two earlier phases were -0.55 and -1.54 respectively. The bud of the regenerate tibia appeared after the second ecdysis and looked like a cone, being 0.5 mm in length. In the next instar one side of the short regenerate tibia was almost completely fused with the apex of the femur, the tibia did not increase in length, and the apical part of the femur was somewhat thickened. From one side of the apex of the femur, where the tibia had been fused, a distinct regenerate tarsus appeared after the third ecdysis. The regenerate basal segment of the tarsus was 0.75 mm in length in the fifth instar, 1.5 mm in length in the sixth and 2.4 mm in

the seventh, *i.e.* the adult stage. The values of α for the growth of the regenerate basal tarsal segment were apparently larger than those of the remaining segment.

No. 31 The right-hand fore leg of a female larva just after the second ecdysis was removed by amputation. The regenerate developed similarly as in the case of the regenerate of the larva which was operated just after the hatching.

No. 78 The left-hand fore leg of a male larva just after the second ecdysis was removed by amputation. The values of α for the growth of the regenerate were successively 8.07 and 6.66 for the tibia and 3.61 and 5.55 for the femur. The values of α for the growth of the regenerate tarsus were 6.66 for the first segment and 2.55 for the remaining segments. The length of the regenerate first tarsal segment was 0.35 mm and 1.40 mm for successive instars, while those of the remaining tarsal segments were 0.60 mm and 1.0 mm respectively.

No. 79 The right-hand fore tibia of a female larva just after the second ecdysis was amputated from the base. The growth of the fore femur without the tibia was not at all affected by the reconstruction of the lost parts. The bud of the regenerate tibia appeared after the third ecdysis and was hemispherical in shape. In the fifth instar the regenerate tarsal segments were recognizable, and they were two in number, being of an equal length. In the sixth instar the differentiation of a tetramerous tarsus was seen. The basal segment was 0.7 mm in length, while the remaining parts being 0.7 mm. The apical (fourth) segment was slightly longer than the second segment. The values of α for the growth of the regenerate of the fore femur were 5.08, 4.81 and 5.66 respectively.

No. 211 The right-hand fore leg of a female larva just after the second ecdysis was removed by amputation from the trochantero-femoral suture. The values of α for the growth of the regenerate were 3.85, 5.09 and 3.10 in order for the tibia and 4.07, 5.27 and 2.10 in order for the femur. The bud of the regenerate tarsus appeared after the sixth ecdysis.

Experiments Class 4

No. 11 The left-hand antenna was amputated from the

base of the flagellum, and the right-hand antenna was cut near the base of the flagellum leaving only 0.5 mm length of the basal flagellar segment just after the first ecdysis. This individual was a female and lost its right-hand fore leg by autotomy at the end of the third instar. It was clearly shown that the growth of the antenna with a 0.5 mm long flagellar segment was at first checked by the reconstruction of the lost parts, and the values of α were changed as -1.30, 5.50, 2.77, 1.21 and 1.90 for successive phases. The left-hand antenna without any stump of the flagellum never regenerated the lost parts as the flagellum, but it developed as a leg. After the third ecdysis the apex of the pedicel was slightly constricted. In the next instar six segments were regenerated, the length of each segment being in the following decreasing order—III, II or V, VI, I, IV. The three basal segments were firmly united and slightly curved. The fourth segment was attached to the antero-lateral portion of the third one. The angle made by the longitudinal axes of the three basal and of the three apical segments was very acute. After the fifth ecdysis the three apical segments turned into a tetramerous tarsus, the third segment to the tibia and the two basal ones fused into the femur. The longitudinal axis of the femur and the same of the tarsus were almost parallel to each other. At the base of the femur an incomplete articulation was still observable, and the apical portion of the tibia was somewhat reflexed. The values of α for the growth of the regenerate fore leg were 5.90 and 2.44 for the femur and 6.70 and 3.33 for the tibia respectively. The values of α for the growth of the regenerate fore tarsus were 2.33 for the first segment and 1.11 for the remaining ones respectively.

No. 86 Distal 5.2 mm of the left-hand fore tibia of a male larva just after the third ecdysis was cut by amputation. It must be noted that the growth of the femur with the wounded tibia was not affected by the regeneration of the lost parts of the leg. Further it was evident that the growth of the wounded tibia was more or less similar to that of the normal one. The bud of the regenerate tarsus appeared in the fifth instar. The absolute lengths of the first tarsal segment were 0.60 mm for the fifth instar and 2.00 for the adult stage. The same of the three remaining segments were 0.90 mm for the fifth instar and 1.50 mm for the adult stage. Here it was clearly demonstrated that the

values of α of the basal segment were greater than those of the remaining parts.

No. 88 The left-hand fore femur of a female larva just before the third ecdysis was amputated from the trochantero-femoral suture. The bud of the regenerate appeared after the fourth ecdysis. This individual died after the sixth ecdysis. The value of α for the growth of the regenerate femur was 6.33 for the first phase. The tibia and tarsus were not seen until the sixth instar.

No. 101 The left-hand fore femur of a female larva just before the third moult was amputated from the trochantero-femoral suture. The bud of the regenerate appeared after the fourth ecdysis. The absolute lengths of the regenerate basal segment were 0.9 mm and 2.0 mm successively, and the same of the remainder were 1.25 mm and 1.5 mm respectively. The value of α for the growth of the basal tarsal segment was 4.50, and that of the remaining parts was 0.80. The values of α for the growth of the regenerate were successively 11.37 and 4.60 for the femur and 7.12 and 5.60 for the tibia.

No. 102 The right-hand fore femur of a male larva just before the third ecdysis was amputated from the trochantero-femoral suture. The bud of the regenerate appeared just after the fourth ecdysis.

2. Experiments Series 2

Experiments Class 5

No. 3 The right-hand mid-leg of a newly hatched female larva was removed by amputation from the trochantero-femoral suture. The bud of the regenerate appeared after the first ecdysis. After the third ecdysis the regenerate tibia was deformed—there occurred a broad constriction at the base, and the entire tibia was deep green in colour. After the fourth ecdysis there occurred a distinct node just basal to the middle portion of the tibia, and this node never disappeared until the adult stage. The bud of the regenerate tarsus appeared after the second ecdysis, but the differentiation of the segments occurred just after the fourth ecdysis. The absolute lengths of the regenerate tarsal

basal segment were 0.7 mm, 1.8 mm and 2.6 mm for successive instars, and those of the remaining parts were 0.9 mm, 1.25 mm and 1.6 mm for respective instars. The values of α for the growth of the regenerate mid-femur were 5.06, 4.91, 2.91, 1.81 and 1.50 for successive instars, and those for the regenerate mid-tibia were 5.26, 1.37, 2.91, 3.63 and 1.90 respectively. The values of α for the regenerate basal tarsal segment were always larger than those of the remaining parts.

No. 4 The left-hand mid-leg of a newly hatched female larva was removed by amputation from the trochantero-femoral suture. The bud of the regenerate appeared after the first ecdysis. The bud of the regenerate tarsus appeared also after the second ecdysis, but it was conical in outline and deep greenish in colour. In the fourth instar the regenerate tarsus still remained in the same condition and not differentiated into segments. After the fourth ecdysis the regenerate tarsus was divided into two segments, the basal one being 0.75 mm in length and the apical one being 0.5 mm in length with the colour deep greenish-blue. The regeneration of this apical part was checked during the course of development. The absolute lengths of the basal part for successive instars were 1.65 mm and 3.0 mm.

No. 15 The left-hand mid-leg of a newly hatched male larva was removed by amputation from the trochantero-femoral suture. In this individual the bud of the regenerate tarsus was unable to differentiate. In the fourth instar about 3.2 mm length of the right-hand fore femur was removed by amputation. The growth of this wounded femur was arrested in the fifth instar. The values of α for the growth of the regenerate mid-femur were 6.36, 4.07, 4.60 and 5.40, and those of the mid-tibia were 6.36, 3.07, 6.00 and 5.40 for successive instars.

No. 24 Distal 1.15 mm length of the right-hand mid-tibia of a newly hatched female was removed by amputation. This individual died after the sixth ecdysis. The growth of the wounded femur was apparently checked in the first and second phases at first. The values of α for the growth of the regenerate mid-tibia were 0.45, 1.12, 0.91, 2.81 and 0.78 for successive instars. The bud of the regenerate tarsus appeared after the second ecdysis. After the third ecdysis the differentiation of the tetramerous segments took place. The absolute values of the regene-

rate tarsus were 1.0 mm and 1.5 mm in length both for the basal and the remaining segments for fifth and sixth instars respectively. There was a node just before the apex of the regenerate tibia.

No. 41 The right-hand mid-leg of a newly hatched larva was removed by amputation. This individual died after the fifth ecdysis. This individual regenerated the right-hand mid-leg with tetramerous tarsus just after the first ecdysis. The growth of the regenerate femur was strongly arrested, a deep incision occurred at the middle of the underside of it in the third instar, and the incised portion turned to a prominent constriction after the fourth ecdysis. Accordingly the growth of the regenerate tibia was also checked. The tetramerous tarsus was reduced to a single-segmented tarsus after the fourth ecdysis.

No. 47 The left-hand mid-leg of a newly hatched female larva was removed by amputation from the trochantero-femoral suture. The bud of the regenerate tarsus which had appeared after the first ecdysis was etiolated after the second ecdysis. After the third ecdysis the differentiation of the tetramerous segments took place. The absolute lengths of the basal segment were 0.35 mm, 1.4 mm and 1.9 mm for the fourth, sixth and seventh instars respectively. The absolute lengths of the remaining part were 0.3 mm, 1.5 mm, and 1.9 mm for the fourth, sixth and seventh instars respectively. The values of α for the growth of the regenerate were 3.25, 4.23 and 1.33 for the femur and 3.87, 3.38 and 1.44 for the tibia successively.

No. 62 Distal 2.5 mm length of the right-hand mid-tibia of a newly hatched female was removed by amputation. The growth of the wounded tibia was comparatively very slow, the values of α being 1.13, 0.87, 1.33 and 1.30 for successive instars. After the third ecdysis a tarsus was regenerated, measuring 0.35 mm in length, and the complete tetramerous segments was differentiated in the next instar (basal segment—0.6 mm, remaining parts 0.8 mm). But the regenerate tarsus was again reduced to a very small single attachment after the fifth ecdysis. The regenerated part of the tibia was easily detectable owing to its narrowness and pale coloration.

No. 287 Distal 1.4 mm length of the right-hand mid-femur of a newly hatched female larva was removed by amputation. The growth of the wounded femur was highly arrested at first

by the reconstruction of the lost parts. The values of α for the regenerate femur were -3.15 , 1.33 , 2.60 , 2.72 and 1.38 for respective instars. The bud of the regenerate tibia and tarsus appeared just after the second ecdysis. The growth of the regenerate tibia and the basal segment of the tarsus was rapid at the third phase and gradually regulated to the slow development, the values of α being 4.66 , 4.27 and 1.38 for the tibia and 4.53 , 3.18 and 0.23 for the tarsus respectively.

No. 291 Distal 1.8 mm of the right-hand mid-femur of a newly hatched larva was removed by amputation. The growth of the wounded femur was highly checked at first by the reconstruction of the lost parts, the values of α being -0.92 , -1.00 , 4.44 and 2.64 for successive instars. The bud of the regenerate tibia appeared just after the second ecdysis. The bud of the regenerate tarsus appeared after the fourth ecdysis and 0.8 mm in length. This individual died in the fifth instar.

No. 296 Distal 2.0 mm length of the left-hand mid-femur of a newly hatched larva was removed by amputation. The growth of the wounded femur was apparently checked by the regeneration of the lost parts, the values of α being -0.95 , 0.33 , 3.07 , 3.09 , 1.87 and 0.72 for successive instars. The values of α for the regenerate basal tarsal segment were 2.81 , 2.12 and -0.27 for successive instars.

No. 301 Distal 1.2 mm length of the right-hand mid-femur of a newly hatched female larva was removed by amputation. The growth of the wounded femur was checked as in the experiment No. 296, the values of α being -1.66 , 2.12 , 1.87 , 2.63 and 1.80 successively. The bud of the regenerate tibia appeared just after the third ecdysis.

No. 14 Distal 1.6 mm length of the right-hand mid-femur of a newly hatched female larva was removed by amputation. The growth of the wounded femur was as in the experiment No. 301, the values of α being 0.00 , -1.21 , 3.00 , 1.23 , 4.25 and 2.77 for successive instars. After the second ecdysis the bud of the regenerate tibia appeared and it measured 0.5 mm in length. After the third ecdysis the tibia was very much curved, and the side was fused with the apex of the regenerate part of the femur. Further the tetramerous tarsus appeared and was 1.0 mm in length. The longitudinal axis of the tarsus was thus perpendicular to that of

the femur. The tibia made no change untill the adult stage. After the fourth ecdysis the regenerate part of the femur was slightly narrowed, and the tarsus was 1.25 mm in length. The longitudinal axis of the tarsus made an acute angle with that of the femur. After the fifth ecdysis the longitudinal axis of the tarsus became again perpendicular to that of the femur. The absolute length of the tarsus was 1.0 mm for the metatarsus and 1.4 mm for the remaining parts.

Experiments Class 6

No. 32 The right-hand mid-leg of a male larva just after the first ecdysis was removed by amputation from the trochanterofemoral suture. After the second ecdysis the leg regenerated. The values of α for the growth of the regenerate were 8.14 for the femur and 7.57 for the tibia in the second phase of the regeneration. In the regenerate leg of the adult stage of this individual, the metatarsus (0.75 mm) was shorter than the remaining parts (1.0 mm).

No. 52 The left-hand mid-leg of a female larva just after the first ecdysis was removed by amputation from the trochanterofemoral suture. The values of α for the growth of the regenerate were 5.41 for the femur and tibia in the second phase of the regeneration. The absolute lengths of the mid-metatarsus were 0.35 mm for the fourth instar and 1.5 mm for the sixth instar. The absolute length of the remaining parts of the tarsus of the same adult was 1.9 mm, and distinctly longer than the metatarsus. The tarsus of the left-hand hind leg was cut by amputation from the base after the first ecdysis. After the second ecdysis the bud of the regenerate tarsus appeared, and it was 0.5 mm in length and two-segmented. After the third ecdysis the tarsus turned to tetramorous. The absolute lengths of the metatarsus were 0.3 mm for the fourth instar and 2.15 mm for the sixth instar, and those of the remaining parts were 0.75 mm for the fourth instar and 1.90 mm for the sixth instar. The value of α was greater for the regenerate hind metatarsus than that for the regenerate mid-metatarsus.

No. 55 Distal 2.5 mm of the right-hand mid-femur of a

male larve just after the first ecdysis was removed by amputation. The growth of the regenerate femur was very much arrested by the reconstruction of the lost parts. After the second ecdysis the bud of the regenerated tibia (0.35 mm) appeared. After the third ecdysis there appeared 0.5 mm length of the tibia with 0.5 mm length of the tarsus. The regenerate tarsus was two-segmented and very much constricted at the base. The colour of the apex of the tibia and the entire tarsus was deep bluish-green. After the fourth ecdysis the regenerate tibia and tarsus were almost entirely etiolated or diminished only leaving a very short, slender, blackish attachment, and the femur was gradually narrowing apically. After the fifth moult the rudiments of the regenerate tibia and tarsus entirely disappeared, and the apex of the regenerate femur was rounded. The values of α for the growth of the wounded femur were 0.42, -1.54 and 0.83 successively.

No. 59 The right-hand mid-tibia of a male larva just after the first ecdysis was cut from the base by amputation. The bud of the regenerate tibia appeared just after the second ecdysis, and was 0.35 mm in length and spherical in size. The growth of the regenerate tibia was very well, the values of α being 1.91, 6.91 and 6.71 for successive instars. The bud of the regenerate tarsus appeared just after the third ecdysis and 0.3 mm in length. After the fourth ecdysis the tetramerous tarsus appeared. The absolute lengths of the regenerate metatarsus were 0.8 mm for the fifth instar and 2.0 mm for the sixth instar, and those of the remaining parts were 1.0 mm for the fifth and 1.35 for the sixth instar. The growth of the femur with an imperfect tibia was almost unaffected by the regeneration of the tibia. It must be noted that the growth of the regenerate tibia was not at all influenced by the reconstruction of the tarsus. The value of α for the growth of the metatarsus was larger than those of the remaining portions.

No. 75 Distal 1.3 mm of the right-hand mid-tibia of a female larva just after the first ecdysis was removed by amputation. The growth of the right-hand mid-femur with a wounded tibia seemed to have been very slightly affected by the reconstruction of the lost parts. The values of α for the growth of the femur in question was 0.93, 1.00 and 0.86 successively. The bud of the regenerate tarsus appeared after the third ecdysis. The

regenerate tarsus was 0.75 mm in length and only one-segmented in the fourth instar. In the fifth instar it became tetramerous (the basitarsus was 0.35 mm and the distal part was 0.75 mm in length.). It is apparent that the growth of the wounded tibia was distinctly checked by the reconstruction of the lost parts, and the values of α were 0.06, 1.50 and 1.40 for successive instars.

No. 203 The right-hand mid-leg of a male larva just before the second ecdysis was removed by amputation from the trochantero-femoral suture. In this individual no regeneration took place. The reason was not clear.

No. 280 Distal 1.2 mm of the right-hand mid-femur of a female larva just after the first ecdysis was removed by amputation. The growth of the wounded femur was highly checked by the reconstruction of the lost parts in the earlier phases of the regeneration. The values of α of the wounded femur were -0.08, -1.50, 2.66, 2.91 and 0.80 for successive instars. The regeneration of the lost tibia was not complete, the regenerate was 1.2 mm in length in the fifth instar, but it disappeared in the next instar. In the seventh instar the tibia again regenerated and it was 3.3 mm in length.

Experiments Class 7

No. 77 The right-hand mid-leg of a female larva just after the second ecdysis was removed by amputation from the trochantero-femoral suture. After the third ecdysis the bud of the regenerate appeared. The growth of the regenerate was very rapid in the two earlier phases of the regeneration, but checked in the third phase. The length of the regenerate tarsus was 2.0 mm for the basal segment and 1.75 mm for the remaining parts in the sixth instar. The same of the regenerate tarsus in the adult stage was 2.9 mm for the basal segment and 2.00 mm for the remaining parts. The value of α for the growth of the basal segment of the regenerate tarsus was larger than those of the remaining parts. The left-hand mid-leg was dropped by amputation in the fifth instar. The bud of the regenerate appeared in the sixth instar, the femur being 0.75 mm in length, the tibia being of the same length as the femur and the tarsus being 0.5 mm in length.

No. 204 The left-hand mid-leg of a female larva just after the second ecdysis was removed by amputation from the trochantero-femoral suture. After the third ecdysis the bud of the regenerate appeared. The values of α for the growth of the regenerate were 5.66, 3.91 and 3.28 for the tibia, 5.66, 2.25 and 1.00 for the femur and 3.83 and 1.00 for the basal tarsal segment for successive phases. It must be noted that in the experimental individual the growth of the mid-femur was much more checked than that of the mid-tibia in the two later phases.

No. 210 The left-hand mid-leg of a larva just after the second ecdysis was removed by amputation from the trochantero-femoral suture. This individual died after the sixth ecdysis. No regeneration of the lost leg occurred during three phases.

No. 213 The right-hand mid-leg of a larva just after the second ecdysis was removed by amputation from the trochantero-femoral suture. The result was almost the same as that of the experiment No. 210.

No. 215 Distal 0.3 mm of the right-hand mid-femur of a male larva just after the second ecdysis was removed by amputation. The growth of the wounded femur was slightly but distinctly checked by the reconstruction of the lost parts, the values of α being 0.53, 0.58 and 0.66 for successive instars, and smaller than those of the normal legs. The growth of the regenerate tibia was slightly rapid.

No. 220 The left-hand mid-leg of a male larva just after the second ecdysis was removed by amputation from the trochantero-femoral suture. In this case the growth of the regenerate femur was much more checked than that of the regenerate tibia in the third phase of regeneration. The values of α for the growth of the regenerate were 8.30 and 6.71 for the tibia, 7.60 and 4.42 for the femur and 6.14 for the basitarsus for successive phases.

No. 64 Distal 0.2 mm of the left-hand mid-tibia of a male larva just after the second ecdysis was removed by amputation. The bud of the regenerate appeared after the third ecdysis, the regenerate apex of the tibia was paler in colour, and the regenerate tarsus was 1.0 mm in length and of four-segmented; the third being the shortest, first and second of the same length, fourth the largest. The growth of the wounded tibia was posi-

tively accelerated in the two later phases of regeneration, and the values of α were larger than those of the normal legs. After the fourth ecdysis each of the tarsal segments was elongated, the basitarsus being 0.8 mm and the remaining parts being 1.5 mm in length. After the fifth ecdysis the absolute length of the basitarsus was 2.25 mm and that of the distal part was 1.9 mm. This indicates that the growth-rate of the basitarsus in the regenerate leg was higher than those of the remaining parts.

Experiments Class 8

No. 87 Distal 3.5 mm of the left-hand mid-tibia of a female larva just after the third ecdysis was removed by amputation. After the fourth ecdysis the lost part of the tibia and the tetramerous tarsus were regenerated. The growth of the wounded tibia was not affected by the reconstruction of the lost parts. Further the growth of the femur with the wounded tibia was also unaffected by the regeneration of the lost part of the tibia in question. The lengths of the tetramerous tarsus were 0.50 mm, 1.00 mm and 1.60 mm successively for the basal segment and 0.60 mm, 1.50 mm and 1.80 mm for the remaining parts. The values of α for the growth of the basal segment were 2.38 and 2.22, and those of the remaining parts were 3.07 and 0.88 respectively.

No. 93 The left-hand mid-leg of a larva just after the third ecdysis was removed by amputation from the trochantero-femoral suture. After the fourth ecdysis the regenerate leg appeared, its tarsus being 0.6 mm in length. The values of α for the growth of the regenerate were 8.11 for the femur and 8.11 for the tibia. This individual died after the sixth ecdysis.

No. 103 The right-hand mid-leg of a larva just after the third ecdysis was removed by amputation from the trochantero-femoral suture. After the fourth ecdysis the regenerate leg appeared, the femur being 1.15 mm in length, the tibia being 1.0 mm, and the tarsus being 0.9 mm. The values of α for the growth of the regenerate were 8.88 for the tibia and 7.22 for the femur.

No. 104 The left-hand mid-leg of a female larva just after the third ecdysis was removed by amputation from the trochantero-femoral suture. The regenerate leg was 0.25 mm for the femur

and 0.75 mm for the tibia in the fifth instar. The values of α for the growth of the regenerate femur were larger than those of the regenerate tibia. The absolute lengths of the regenerate tarsus were 0.25 mm, 0.75 mm and 1.4 mm for the basitarsus successively, and 0.1 mm, 1.0 mm and 1.4 mm for the remaining parts successively. The value of α for the growth of the regenerate basitarsus was larger than that of the distal part in the first regenerating phase, while an entire reverse was true in the second regenerating phase.

Experiments Class 9

No. 227 The left-hand mid-leg of a female larva was removed by amputation from the trochantero-femoral suture after the fourth ecdysis. After the fifth ecdysis the bud of the regenerate appeared, the femur being 3.0 mm and the tibia being 2.2 mm in length. The values of α for the growth of the regenerate were 10.16 for the tibia and 8.00 for the femur.

No. 94 The left-hand mid-leg of a male larva was removed by amputation from the trochantero-femoral suture just after the fourth ecdysis. The regenerate femur was 2.7 mm in length, being 0.4 mm longer than the regenerate tibia.

No. 95 Mid-legs of a male larva were removed by amputation from the trochantero-femoral suture after the fourth ecdysis. The right-hand regenerate femur was 2.3 mm in length, being 0.2 mm shorter than the regenerate tibia. No regeneration occurred on the left side.

3. Experiments Series 3

Experiments Class 10

No. 5 The right-hand hind leg of a newly hatched female larva was removed by amputation from the trochantero-femoral suture. The values of α for the growth of the regenerate were 3.00, 7.66, 2.30 and 1.50 for the femur and 3.00, 7.66, 2.30 and 1.60 for the tibia for successive phases.

No. 6 The right-hand hind leg of a newly hatched female larva was removed by amputation from the trochantero-femoral suture. The values of α for the growth of the regenerate were

4.40, 2.16, 2.14, 1.70 and 1.55 for the femur and 5.50, 3.33, 2.78, 2.80 and 1.88 for the tibia for successive phases. The bud of the regenerate tarsus appeared just after the first ecdysis, but segmentation was never seen at that time. Further the segmentation of the regenerate tarsus had never been observed until the fourth instar when the bud was 0.35 mm in length and conical in shape. After the fourth ecdysis the tetramerous tarsus was observed, the basitarsus being 0.75 mm and the remaining parts being 0.9 mm in length. The absolute lengths of the regenerate basitarsus were 1.9 mm for the sixth instar and 2.5 mm for the seventh one, and those of the remaining parts were 1.7 mm for the sixth instar and 2.0 mm for the seventh one. The values of α for the growth of the regenerate basitarsus were 4.00 and 1.33, and those of the remaining parts were 2.80 and 0.77 for successive phases.

No. 16 Distal 1.6 mm of the left-hand leg of a newly hatched larva was removed by amputation. After the third ecdysis the regenerate was dropped, and the observation was stopped. The bud of the tarsus did not appear even after the third ecdysis. The growth of the wounded femur was very rapid in the first regenerating phase, and that of the regenerating tarsus was very rapid in the second phase.

No. 17 Distal 1.65 mm of the left-hand fore femur of a newly hatched larva was removed by amputation. The growth of the wounded femur was apparently checked by the reconstruction of the lost parts, the absolute lengths being 1.5 mm, 1.4 mm, 1.25 mm, 2.25 mm and 5.0 mm for successive instars. The regenerate femur was slightly twisted at the regenerating portion. After the third ecdysis the basitarsus was curved very much.

No. 22 The left-hand hind leg of a newly hatched female larva was removed by amputation from the trochantero-femoral suture. The values of α for the growth of the regenerate femur were 2.77, 8.83, 2.69, 1.45 and 1.27 and those of the tibia were 2.77, 7.66, 2.92, 2.00 and 1.27 for successive phases. The absolute lengths of the regenerate basitarsus were 0.75 mm, 1.5 mm and 2.0 mm, and those of the remaining parts were 1.0 mm, 1.75 mm and 1.9 mm for successive instars (V, VI, VII). The values of α for the growth of the regenerating basitarsus were 2.72 and 1.18, and those of the remaining parts were 2.18 and 0.27 for successive regenerating phases.

No. 25 The right-hand hind leg of a newly hatched female larva was removed by amputation from the trochantero-femoral suture. The values of α for the growth of the regenerate femur were 2.81, 6.00, 2.25, 1.72 and 2.00, and those of the regenerate tibia were 3.36, 5.10, 2.50, 1.72 and 1.57 for successive phases. The absolute lengths of the regenerate tarsus for successive instars were 1.6 mm, 2.25 mm and 2.6 mm, for the basitarsus and 1.6 mm, 2.0 mm and 2.0 mm for the remaining tarsal segments. The values of α for the growth of the regenerate tarsus were 1.36 and 0.85 for the basitarsus and 0.90 and 0.00 for the remaining parts respectively. No growth in length was seen in the regenerating three apical tarsal segments (taken together) in the last regenerating phase.

No. 42 The right-hand hind leg of a newly hatched larva was removed by amputation from the trochantero-femoral suture. This individual died just after the second ecdysis. The absolute lengths of the regenerate was 0.6 mm for the femur and 0.6 mm for the tibia.

No. 48 The left-hand hind leg of a newly hatched female larva was removed by amputation from the trochantero-femoral suture. This individual died in the course of the sixth ecdysis. The values of α for the growth of the regenerate femur were 2.60 for the first phase and 3.00 for the fourth and those of the tibia were 2.60 for the first and 2.10 for the fourth. In this individual the regenerate of the tarsus never appeared during the larval period.

No. 53 The antennae of a newly hatched larva were amputated at the base of the fourth segment. The left-hand hind leg was dropped at the middle of the first instar. The absolute lengths of the regenerate antennae were 3.0 mm (IV) and 5.5 mm (V) for the left side and 3.7 mm (IV) and 5.5 mm (V) for the right side. The values of α for the growth of the regenerate left-hand antenna were very high but slightly lower than those of the hind leg.

No. 286 Distal 2.4 mm of the right-hand hind femur of a newly hatched male larva was removed by amputation. The growth of the regenerate tibia was very slow or entirely stopped. Of course the regeneration of the tarsus never occurred. The growth of the wounded femur was very much arrested by the

reconstruction of the lost parts. It is noteworthy that the wounded femur had never increased in length during the larval stage. Thus the values of α for the growth of the wounded femur were -3.15 , -1.33 , 0.90 , -1.00 and 0.00 for successive regenerating phases.

No. 288 Distal 2.1 mm of the left-hand hind femur of a newly hatched female larva was removed by amputation. The growth of the wounded femur was apparently arrested for the two first phases, the values of α being -2.00 , -1.25 , 4.35 , 4.33 , 2.10 and 1.54 for successive phases. The regenerate tibia was very much curved, and the measurement was almost impossible. The values of α for the growth of the regenerate basitarsus were comparatively large and 4.11 , 1.60 and 2.72 for three later phases.

No. 290 Distal 1.2 mm of the right-hand hind femur of a newly hatched female larva was removed by amputation. This individual died during the fourth ecdysis. The growth of the wounded femur was very slow owing to the regeneration of the lost parts. After the third ecdysis the bud of the tibia appeared and was 0.5 mm in length.

No. 294 Distal 0.9 mm of the right-hand hind femur of a newly hatched female larva was removed by amputation. The growth of the wounded femur was checked for the earlier phases, the values of α being -0.52 , 3.50 , 1.46 and 1.85 for successive phases. The bud of the regenerate tibia appeared after the second ecdysis and the values of α were 3.90 , 2.27 and 1.85 for successive phases. The value of α for the fourth regenerating phase of the basitarsus was so high as 3.00 , but in the next phase it became negative, taking the value -0.27 .

No. 295 Distal 0.6 mm of the left-hand hind femur of a newly hatched larva was removed by amputation. This individual died after the third ecdysis. The growth of the wounded femur was also checked by the reconstruction of the lost parts. The regeneration never occurred on the tibia.

No. 297 Distal 1.7 mm of the right-hand hind femur of a newly hatched larva was removed by amputation. The growth of the wounded femur was highly checked at first. The values of α for the femur were -6.50 , 6.28 , 0.85 , 2.55 and 11.1 for successive phases. The values of α for the growth of the regen-

nerate tibia were 3.25 and 3.00, and those of the basitarsus were 4.20 and 1.22 for successive phases.

Experiments Class 11

No. 33 The left-hand hind leg of a female larva was removed by amputation from the trochantero-femoral suture just after the first ecdysis. The growth of the regenerate leg was quite ideal in curve when plotted on the chart. The values of α for the growth of the regenerate were 4.81, 4.90, 2.40 and 1.33 for the femur and 4.81, 4.90, 2.30 and 1.36 for the tibia for successive phases.

No. 38 The left-hand hind leg of a female larva was removed by amputation from the trochantero-femoral suture just after the first ecdysis. This individual lost its right-hand fore leg by autotomy just after the first ecdysis. The values of α for the growth of the regenerate fore leg were 4.70, 4.83, 2.40 and 1.30 for the femur and 4.30, 6.06, 2.10 and 1.90 for the tibia for successive phases. Those of the regenerate hind leg were 2.60, 2.83, 2.90 and 1.60 for the femur for successive phases. The growth of the regenerate hind tibia was abnormal.

No. 56 The left-hand hind leg of a female larva was removed by amputation from the trochantero-femoral suture just after the first ecdysis. The values of α for the growth of the regenerate were 2.43, 4.00, 1.90 and 1.33 for the femur and 2.35, 4.15, 1.90 and 1.33 for the tibia for successive phases. The absolute lengths of the regenerate tarsus were 1.5 mm, 2.4 mm and 3.0 mm for the basitarsus and 1.5 mm, 2.2 mm and 2.4 mm for the remaining parts. The values of α for the growth of the basitarsus were always larger than those of the remaining parts.

No. 60 The right-hand hind leg of a larva was removed by amputation from the trochantero-femoral suture just after the first ecdysis. This individual died during the fourth ecdysis. The absolute lengths of the regenerate were 0.5 mm and 2.0 mm for successive phases.

No. 63 The right-hand hind leg of a female larva was removed by amputation from the trochantero-femoral suture just after the first ecdysis. The values of α for the growth of the regenerate were 5.72, 7.25 and 2.25 for the femur and 5.72, 6.62

and 2.87 for the tibia for successive phases. The absolute lengths of the regenerate tarsus were 1.25 mm and 1.8 mm for the basitarsus, and 1.25 mm and 1.5 mm for the remaining parts. The value of α for the growth of the basitarsus was larger than that of the distal part.

No. 68 The right-hand hind leg of a larva was removed by amputation from the trochantero-femoral suture just after the first ecdysis. This individual died after the fifth ecdysis. The values of α for the growth of the regenerate were 6.42 and 3.57 for the femur, and 5.57 and 4.42 for the tibia for successive phases. The absolute lengths of the regenerate tarsus were 0.75 mm and 2.00 mm for the basitarsus, and 0.75 mm and 1.50 mm for the remaining parts. The value of α for the growth of the basitarsus was larger than that of the distal part.

No. 71 Distal 1.8 mm of the right-hand hind femur was removed by amputation just after the first ecdysis. The growth of the wounded femur was highly affected by the regeneration of the lost parts. After the second ecdysis a pit-like bud of the regenerate appeared. After the third ecdysis 0.65 mm of a tetramerous tarsus was regenerated. After the next ecdysis the regenerate tarsus was entirely diminished, and the femur was gradually narrowed apically. In this case no regeneration took place in the tibia.

No. 72 Distal 0.2 mm of the right-hand hind femur of a larva was removed by amputation just after the first ecdysis. The growth of the wounded femur was normal, and the regeneration of the lost parts never occurred. The apex of the wounded femur had a very small tubercle-like minute process.

No. 73 Distal 2.9 mm of the right-hand hind tibia was removed by amputation just after the first ecdysis. This individual died just after the sixth ecdysis. The values of α for the growth of the wounded tibia were 1.00 for the first phase and 0.92 for the third phase. No regeneration took place in the tarsus.

No. 278 Distal 2.3 mm of the left-hand hind femur of a female larva was removed by amputation just after the first ecdysis. The growth of the wounded femur was apparently affected by the reconstruction of the lost parts at the earlier regeneration phases, the values of α being 0.00, 0.58, -2.40, 4.30 and 4.25 for successive phases. The regenerate tibia at

first appeared just after the fourth ecdysis. The values of α for the growth of the regenerate tibia were 2.50 and 7.28 for successive phases.

No. 281 Distal 2.2 mm of the left-hand hind-femur of a male larva was removed by amputation just after the first ecdysis. The growth of the wounded femur was very much checked by the reconstruction of the lost parts, the values of α were -0.41 , 0.14, 0.46 and 0.00 for successive phases. After the third ecdysis 0.45 mm length of the regenerate tibia appeared, but the bud diminished just after the third ecdysis.

Experiments Class 12

No. 55 The left-hand hind leg of a female larva was removed by amputation from the trochantero-femoral suture just after the second ecdysis. This individual died after the sixth ecdysis. The values of α for the growth of the regenerate were 4.40 and 2.55 for the femur, and 4.90 and 2.22 for the tibia for successive phases. The absolute lengths of the regenerate tarsus were 1.85 mm and 2.5 mm for the basitarsus, and 1.85 mm and 2.0 mm for the remaining parts. The value of α for the growth of the basitarsus was larger than that of the remaining parts.

No. 80 The right-hand hind leg of a male larva was removed by amputation from the trochantero-femoral suture just after the second ecdysis. The values of α for the growth of the regenerate were 3.75 and 2.80 for the femur, and 5.41 and 3.20 for the tibia for successive phases. The absolute lengths of the regenerate tarsus were 0.6 mm and 2.0 mm for the basitarsus, and 1.0 mm and 1.5 mm for the remaining parts. The value of α for the growth of the basitarsus was very large (5.30) and that of the distal part was 1.70.

No. 206 The right-hand hind leg of a male larva was removed by amputation from the trochantero-femoral suture just after the second ecdysis. In this individual the regeneration never occurred.

No. 207 The right-hand hind leg of a female larva was removed by amputation from the trochantero-femoral suture just after the second ecdysis. In this individual the regeneration never occurred.

No. 209 The right-hand hind leg of a female larva was removed by amputation from the trochantero-femoral suture just after the second moult. After the fourth ecdysis the bud of the regenerate appeared. The values of α for the growth of the regenerate were 6.55 for the femur and 7.44 for the tibia. The regenerate was dropped during the sixth ecdysis.

No. 212 The right-hand hind leg of a female larva was removed by amputation from the trochantero-femoral suture just after the second moult. Until the adult stage the regeneration was never observed.

No. 214 The result was the same as in the experiment No. 212.

No. 216 The left-hand hind leg of a female larva was removed by amputation from the trochantero-femoral suture just after the second ecdysis. After the fifth ecdysis the bud of the hind leg was regenerated, the femur being 1.5 mm and the tibia being 1.2 mm in length. After the sixth ecdysis the regenerate was etiolated and diminished.

No. 217 The result was the same as in the experiment No. 214. No regeneration took place.

No. 218 The right-hand hind leg of a male larva was removed by amputation from the trochantero-femoral suture just after the second ecdysis. The values of α for the growth of the regenerate were 7.80 and 4.30 for the femur, 6.10 and 6.00 for the tibia and 5.60 for the basitarsus. The basitarsus appeared just after the fourth ecdysis.

No. 223 The right-hand hind leg of a female larva was removed by amputation from the trochantero-femoral suture just after the second ecdysis. The bud of the regenerate basitarsus appeared just after the fourth ecdysis. The growth of the regenerate was quite ideal. The values of α for the growth of the regenerate were 8.45, 3.75 and 1.90 for the femur, 7.27, 5.08 and 2.50 for the tibia, and 3.83 and 1.40 for the basitarsus for successive phases.

No. 224 The left-hand hind leg of a male larva was removed by amputation from the trochantero-femoral suture just after the second ecdysis. In this individual the regenerate tarsus never appeared at all. The values of α for the growth of the

regenerate were 5.23 and 8.11 for the femur, and 5.38 and 8.00 for the tibia for successive phases.

No. 225 The right-hand hind leg of a female larva was removed by amputation from the trochantero-femoral suture just after the second ecdysis. The growth of the regenerate of this individual was typical. The values of α for the growth of the regenerate were 8.63, 5.90 and 1.90 for the femur, 9.27, 5.60 and 2.09 for the tibia, and 4.60 and 1.54 for the basitarsus for successive phases. It must be noted that the regenerate basitarsus was as long as the normal basitarsus of the opposite side in the adult stage.

No. 226 The left-hand hind leg of a female larva was removed by amputation from the trochantero-femoral suture just after the second ecdysis. This individual lost its right-hand hind leg by autotomy in the third instar. The growths of the regenerates were quite typical. The values of α for the left side were 7.00, 5.10 and 2.33 for the femur and 7.50, 5.33 and 3.44 for the tibia, and those for the right side were 8.50, 5.10 and 2.55 for the femur and 7.60, 6.20 and 2.77 for the tibia for successive phases.

Experiments Class 13

No. 92 The left-hand hind leg of a female larva was removed by amputation from the trochantero-femoral suture just after the third ecdysis. The individual died during the sixth ecdysis. The growth of the regenerate femur was rapid, the value of α being 6.00, but that of the tibia was slow owing to the reconstruction of the tarsus, the value of α being 2.10. But the bud of a regenerate tarsus never appeared.

No. 97 The right-hand hind leg of a male larva was removed by amputation from the trochantero-femoral suture just after the third ecdysis. The values of α for the growth of the regenerate were 3.90 for the femur and 6.90 for the tibia.

No. 98 The left-hand hind leg of a female larva was removed by amputation from the trochantero-femoral suture just after the third ecdysis. The values of α for the growth of the regenerate were 11.70 and 7.71 for the femur, and 10.80 and 7.57 for the tibia for successive phases.

No. 99 The left-hand hind leg of a male larva was re-

moved by amputation from the same suture just after the third ecdysis. The growth of the regenerate was slightly more rapid than that of the experiment No. 97.

No. 228 The right-hand hind leg of a female larva was removed by amputation from the trochantero-femoral suture just after the third ecdysis. In this individual no regeneration took place in the lost leg.

No. 229 The right-hand hind leg of a female larva was removed by amputation from the trochantero-femoral suture just after the third ecdysis. The values of α for the growth of the regenerate were 9.40 for the femur and 9.10 for the tibia.

No. 234 The right-hand hind leg of a female larva was removed by amputation from the trochantero-femoral suture just after the third ecdysis. The values of α for the growth of the regenerate were 9.46 and 5.22 for the femur, and 9.76 and 4.33 for the tibia for successive phases.

Experiments Class 14

No. 46 The right-hand hind leg of a female larva was removed by amputation from the trochantero-femoral suture just after the fourth ecdysis. After the fifth ecdysis the regenerate appeared, the femur being 2.1 mm and the tibia 2.0 mm in length. The metatarsus of the regenerate was 0.35 mm in length. This individual died just before the sixth ecdysis. The right-hand antenna of this individual was cut at the base of the fourth segment. The growth of the regenerate antenna was at first slightly checked.

No. 236 The right-hand hind leg of a female larva was removed by amputation from the trochantero-femoral suture just after the fourth ecdysis. In this individual no regeneration took place.

No. 238 Distal 10.2 mm of the right-hand hind leg of a larva was removed by amputation just after the fourth ecdysis. After the fifth ecdysis the wounded femur regenerated the lost parts, the femur being 6.0 mm and the tibia 4.2 mm in length. In this case the growth of the wounded femur was not checked by the regeneration of the lost parts, the value of α being 4.00.

No. 237 The left-hand hind leg of a female larva was

removed by amputation from the trochantero-femoral suture just after the fourth ecdysis. The values of α for the growth of the regenerate were 5.90 for the femur, 7.20 for the tibia and 3.10 for the basitarsus.

4. Experiments Series 4

Experiments Class 15

No. 43 The mid-legs of a larva were removed by amputation from the trochantero-femoral suture just after the hatching. In the next instar the regenerates appeared, the femur measuring 0.5 mm and the tibia also being 0.5 mm in length. This individual died just before the second ecdysis.

No. 36 The mid-legs of a female larva just after the first ecdysis were amputated from the trochantero-femoral suture. The growth of the regenerate mid-legs was as rapid as an ideal case. The values of α for the growth of the left-hand mid-leg were 4.72, 3.50, 1.58 and 2.14 for the femur and 4.63, 3.41, 1.75 and 2.00 for the tibia for successive phases. The same of the right-hand mid-leg were 4.72, 3.50, 1.58 and 2.14 for the femur, and 4.63, 3.41, 1.75 and 2.00 for the tibia. The left-hand fore leg was dropped by autotomy from the trochantero-femoral suture just after the third ecdysis. The growth of the regenerate fore leg was also very rapid, the values of α being 4.75 and 4.00 for the femur and 4.75 for the tibia. The left-hand hind tibia was damaged in the fourth instar, and distal 7.0 mm of the tibia was lost. The growth of the femur with the wounded tibia was apparently checked, the values of α being 0.83, 0.50 for the first two phases. The growth of the wounded tibia was highly influenced by the reconstruction of the lost parts. The values of α were -1.41, 2.91 and 5.00 for successive phases.

No. 58 b The mid-legs of a female larva were amputated from the trochantero-femoral suture just after the second ecdysis. The values of α for the growth of the left-hand mid-leg were 2.54, 2.80 and 1.50 for the femur, and 2.45, 2.60 and 1.62 for the tibia for successive phases. The same of the right-hand mid-leg were 2.70 and 2.00 for the femur, and 2.45, 2.80 and 1.50 for the tibia for successive phases.

No. 96 The mid-legs of a male larva were removed from the trochantero-femoral suture just after the third ecdysis. The values of α were 5.70 for the growth of the regenerate femur and 6.00 for the regenerate tibia.

Experiments Class 16

No. 10 The hind legs of a newly hatched female larva were removed by amputation from the trochantero-femoral suture. The values of α for the growth of the left-hand regenerate were 4.36, 4.16 and 2.30 for the tibia, and 5.00, 2.08 and 1.50 for the femur, and those of the right-hand regenerate were 4.36, 1.08 and 1.50 for the tibia, and 4.90, 0.75 and 1.20 for the femur for successive phases. The absolute lengths of the regenerate tarsi were 0.75 mm, 2.25 mm and 3.00 mm respectively for the left-hand basitarsus, 1.25 mm, 2.10 mm and 2.60 mm respectively for the left-hand remaining parts, 1.60 mm, 2.35 mm and 2.80 mm respectively for the right-hand basitarsus, 1.50 mm, 1.75 mm and 2.10 mm respectively for the right-hand remaining parts. The growth of the regenerate basitarsus was greater than that of the remaining parts. The right-hand mid-leg of this individual had a two-segmented tarsus in the fifth instar, but in the next stage the latter became to assume the normal form with five segments.

No. 44 The hind legs of a newly hatched male larva were removed by amputation from the trochantero-femoral suture. The growth of the regenerates was typical. The lengths of the regenerate left-hand tarsus were 1.0 mm and 2.0 mm for the basitarsus, and 1.1 mm and 2.0 mm for the remaining parts for successive instars. Here it is evident that the growth of the regenerate basitarsus was higher than that of the remaining parts. The lengths of the regenerate right-hand tarsus were 1.25 mm and 1.25 mm for the basitarsus, and 0.75 mm and 1.50 mm for the remaining parts for successive phases. In this case the regenerate basitarsus showed no development in length, and only the remaining parts made a rapid growth.

No. 37 The hind legs of a newly hatched female larva were removed by amputation from the trochantero-femoral suture. The values of α for the growth of the left-hand regenerate were 4.50, 5.09, 1.50 and 2.00 for the femur, and 4.63, 1.83 and 1.75

for the tibia for successive phases. The values of α for the growth of the right-hand regenerate were 4.50, 5.09, 1.50 and 1.87 for the femur, and 4.50, 4.63, 1.83 and 1.62 for the tibia for successive phases. The absolute lengths of the regenerate tarsus were 2.0 mm and 2.5 mm for the basitarsus, and 2.0 mm and 2.2 mm for the remaining parts for successive phases. In this case the growth of the regenerate basitarsus was evidently more rapid than that of the distal part.

No. 67 The hind legs of a larva were removed by amputation from the trochantero-femoral suture just after the first ecdysis. The right-hand regenerate was dropped during the fourth ecdysis. This individual died in the fifth instar. The values of α for the growth of the right-hand regenerate were very high, being 6.66 for the femur and 5.60 for the tibia. The same of the left-hand regenerate were 6.66 and 5.09 for the femur, and 5.40 and 4.90 for the tibia for successive phases. The absolute lengths of the regenerate tarsus were 0.90 mm and 2.25 mm for the basitarsus, and 0.75 mm and 1.75 mm for the remaining parts for successive phases. The growth of the regenerate tarsus was very rapid both for the basitarsus and for the remaining parts.

No. 201 The hind legs of a male larva were amputated from the trochantero-femoral suture just after the first ecdysis. The growth of the left-hand regenerate was very rapid, the values of α being 5.58, 11.66 and 2.23 for the femur, and 5.58, 11.77 and 2.07 for the tibia for successive phases, while that of the right-hand regenerate was very slow, the values of α being 0.1 for the femur and tibia. The right-hand regenerate was dropped during the fourth ecdysis:

No. 208 The hind legs of a male larva were amputated from the trochantero-femoral suture just after the second ecdysis. No regeneration took place on the right side. The values of α for the growth of the left-hand regenerate were 9.77 and 5.80 for the femur, and 8.66 and 6.70 for the tibia for successive phases. The absolute lengths of the regenerate basitarsus were 0.5 mm for the fifth instar and 1.9 mm for the next. Therefore, the growth of the regenerate basitarsus was very rapid, the value of α being 6.70.

No. 221 The hind legs of a female larva were amputated from the trochantero-femoral suture just after the second ecdysis.

The growth of the right-hand regenerate was rapid at first, but very much checked by the etiolation of the tarsus. The value of α for the femur was 1.71 in the last phase, and those for the tibia were 8.27, -0.30 and -1.85 for successive phases. In the left-hand regenerate the growth was as rapid as in the normal case, the values of α being 8.54, 5.40 and 3.85 for the femur, and 8.54, 4.70 and 4.71 for the tibia for successive phases.

No. 222 The hind legs of a male larva were amputated from the trochantero-femoral suture just after the second ecdysis. The growth of the regenerates was typical. The values of α of the left-hand regenerate were 10.87 and 4.38 for the femur, 10.87 and 4.07 for the tibia and 4.15 for the basitarsus for successive phases. The same of the right-hand regenerate were 9.87 and 3.92 for the femur, 7.50 and 4.92 for the tibia and 5.84 for the basitarsus for successive phases.

No. 90 The hind legs of a female larva were removed by amputation from the trochantero-femoral suture just after the third ecdysis. This individual died in the sixth instar. The values of α for the regenerate femur and tarsus were 10.00 and 9.75 respectively.

No. 100 The hind legs of a female larva were amputated from the trochantero-femoral suture just after the third ecdysis. The growth of the right-hand regenerate was abnormal. The values of α for the growth of the regenerate femur and tibia were 5.70 and 5.70 respectively.

Experiments Class 17

No. 30 The right-hand mid-leg and the left-hand hind leg of a female larva were removed from the trochantero-femoral suture just after the hatching. The growth of the regenerates was typical. The values of α for the growth of the regenerates were 5.50 and 1.54 for the hind tibia, 5.50 and 1.18 for the hind femora, 5.50 and 1.09 for the mid-tibia, and 5.50 and 1.27 for the mid-femur for successive phases. This female died in the sixth instar. The regenerate mid-tibia was almost as long as the normal mid-tibia of the opposite side in the sixth instar.

No. 34 The right-hand fore leg and the left-hand mid-leg

of a male larva were amputated from the trochantero-femoral suture just after the first ecdysis. The growth of the regenerate fore leg was typical, the values of α being 5.10, 4.38 and 2.50 for the femur, and 4.30, 4.76 and 2.90 for the tibia for successive phases. Just after the third ecdysis the apical portion of the regenerate mid-femur was slightly constricted and curved, and the tibia and tarsus took quite abnormal situation as shown in the text-figure. In the next ecdysis the tibia and tarsus diminished and were attaching to the apex of the femora as a small tubercle. The growth of the femur was checked at the third regenerating phase. The values of α for the growth of the regenerate mid-femur were 4.80, -0.38 and 2.40 for successive phases.

No. 35 The right-hand mid-leg and the left-hand hind leg of a female larva were amputated from the trochantero-femoral suture just after the first ecdysis. The values of α for the growth of the regenerates were 4.27, 7.83 and 2.71 for the mid-femur, 4.27, 8.33 and 1.57 for the mid-tibia, 5.00, 12.00 and 1.00 for the hind femur, and 5.00, 11.33 and 1.00 for the hind tibia for successive phases. This individual died in the sixth instar.

No. 45 The left-hand mid-leg and the right-hand hind leg of a newly hatched male larva were removed from the trochantero-femoral suture. The growth of the regenerates was normal. In the adult stage the regenerate mid-leg was exactly as long as the normal mid-leg of the opposite side. The absolute lengths of the regenerate mid-tarsus were 2.0 mm and 3.0 mm for the basitarsus, and 1.8 mm and 2.0 mm for the remaining parts for the fifth and sixth instars respectively.

No. 54 b The hind legs and the left-hand fore leg of a female larva were amputated from the trochantero-femoral suture. The values of α for the growth of the hind regenerates were 6.55, 3.69 and 2.22 for the left-hand femur, 5.77, 4.23 and 2.55 for the left-hand tibia, 6.55, 3.69 and 2.22 for the right-hand femur, and 5.77, 3.07 and 3.55 for the right-hand tibia for successive phases.

No. 59 b The left-hand fore leg and the right-hand mid-leg of a male larva were removed from the trochantero-femoral suture just after the second ecdysis. The values of α for the growth of the regenerates were 3.69 and 5.44 for the left-hand fore femur, 3.46 and 6.00 for the left-hand fore tibia, 3.53 and 5.00 for the

right-hand mid-femur, and 3.61 and 5.33 for the right-hand mid-tibia for successive phases.

No. 65 b The left-hand mid-leg and the right-hand hind leg of a larva were amputated from the trochantero-femoral suture just after the first ecdysis. The values of α for the growth of the regenerates were 6.50 and 5.20 for the left-hand mid-femur, 7.75 and 5.20 for the left-hand mid-tibia, 7.00 and 4.70 for the right-hand hind femur, and 6.50 and 5.40 for the right-hand hind tibia for successive phases. The growth of the regenerate mid-basitarsus was more rapid than that of the distal part of the regenerate mid-tarsus. On the contrary the growth of the regenerate hind tarsus was much more rapid than that of the distal part. This individual died during the fifth ecdysis.

No. 66 The right-hand fore leg of a larva was amputated from the trochantero-femoral suture just after the first ecdysis. This individual lost its left-hand mid-leg in the second instar by autotomy. The values of α for the growth of the regenerates were 6.33 and 5.08 for the right-hand fore femur, 9.22 and 4.91 for the right-hand fore tibia, 4.20 and 5.00 for the left-hand mid-femur, and 5.00 and 3.50 for the left-hand mid-tibia for successive phases. This individual died in the fifth instar. The regenerate tarsus of the mid-leg was two-segmented.

No. 69 The left-hand fore leg and the right-hand hind leg of a larva were amputated from the trochantero-femoral suture just after the first ecdysis. This insect died in the fifth instar. The values of α for the growth of the regenerates were 7.30 and 3.00 for the left-hand fore femur, 7.61 and 3.68 for the left-hand fore tibia, 6.38 and 3.25 for the right-hand hind femur, and 6.69 and 3.50 for the right-hand hind tibia for successive phases. The absolute lengths of the regenerate tarsi were 0.9 mm and 2.00 mm for the fore basitarsus, 0.9 mm and 1.75 mm for the remaining parts of the tarsus, 0.75 mm and 2.00 mm for the hind basitarsus, and 0.9 mm and 1.75 mm for the remaining parts for successive phases.

No. 74 The right-hand fore leg of a larva was amputated from the trochantero-femoral suture just after the first ecdysis. Distal 2.6 mm of the left-hand mid-leg was removed by amputation in the same instar. The values of α for the growth of the regenerate fore leg were 9.27 and 3.92 for the femur, and 8.45 and

4.50 for the tibia for successive phases. The growth of the wounded mid-femur was apparently checked by the reconstruction of the lost parts, the values of α being 0.70, -0.45 and 0.00 for successive phases. After the second ecdysis there appeared a very low tubercle-like process on the apex of the wounded femur. After the third ecdysis this process made a slight growth, the length being 0.35 mm, with an attachment on the apex. In the next instar it became 0.5 mm in length. No tarsus was regenerated at all. This individual died in the fifth instar.

No. 82 The right-hand hind leg of a female larva was removed by amputation from the trochantero-femoral suture just after the second ecdysis. Distal 4.6 mm of the left-hand mid-femur was removed by amputation in the same instar. The growth of the regenerates was normal. The lengths of the regenerate hind tarsus were 0.65 mm and 2.20 mm for the femur, and 0.75 mm and 2.00 mm for the tibia for successive phases. The regenerate mid-leg was dropped in the sixth instar. The wounded femur was very much constricted at the base just before the third ecdysis, but never dropped. After the fourth ecdysis there appeared very curious segments: the femur (2.1 mm in length) and the tibia (2.0 mm in length) were normal, the basitarsus was 0.5 mm in length, the second and third tarsal segments were 0.25 mm in length taken together, the fourth one was very curious and 0.35 mm in length. At the middle of the fourth segment there was attached an empodium-like process. At the apex of the fourth segment there was attached another leg (consisting of a tibia and a tetramerous tarsus), thus the fourth segment playing a mirror, of both legs. The measurements of this curious leg are as follows: tibia 1.5 mm, basitarsus 0.5 mm, second and third segments taken together 0.30 mm. There was recognizable a deep bluish tubercle on the top of the tibia. The apex of the tibia was irregularly shaped. This curious leg was dropped in the course of the next ecdysis.

No. 91 The right-hand fore leg and the left-hand hind leg of a female larva were amputated from the trochantero-femoral suture. The values of α for the regenerate legs for the second regenerating phase were 18.57 for the fore femur, 15.41 for the fore tibia, 17.28 for the hind femur and 13.00 for the hind tibia. This individual died in the sixth instar.

5. Experiments Series. 5

Experiments Class 18

No. 49 The left-hand fore leg of a newly hatched larva was amputated from the trochantero-femoral suture. The right-hand fore leg of the same individual was removed from the trochantero-femoral suture just after the first ecdysis. The growth of the regenerate left-hand fore leg was normal. The absolute lengths of the regenerate tarsus were 0.7 mm and 1.5 mm for the basitarsus, and 0.75 mm and 1.25 mm for the remaining parts for successive phases. The regeneration of the right-hand fore tibia was stopped in the fourth instar. This caused the growth of the regenerate right-hand fore femur in the third regenerating phase slightly checked. The shape of the right-hand fore femur was quite different from that of the normal one and somewhat clavate with deep greenish coloration. This insect died in the fifth instar.

No. 273 The right-hand fore leg of a male larva was removed from the trochantero-femoral suture just after the first ecdysis. The left-hand fore leg of the same individual was removed from the trochantero-femoral suture just after the third ecdysis. The values of α for the growth of the right-hand regenerate were 7.84, 4.45 and 3.00 for the femur, 7.30, 4.81 and 3.10 for the tibia, and 3.90 and 2.10 for the basitarsus for successive phases. The values of α for the left-hand regenerate were large, being 11.10 for the femur and 10.80 for the tibia in the second regenerating phase.

No. 239 The left-hand mid-leg of a newly hatched male larva was removed from the trochantero-femoral suture. The right-hand mid-leg of the same insect was amputated from the trochantero-femoral suture after the first ecdysis. The values of α for the growth of the left-hand regenerate were 6.57, 3.29, 4.14 and 2.00 for the femur, 6.57, 3.29, 4.28 and 2.10 for the tibia, and 2.82, 5.00 and 1.70 for the basitarsus for successive phases. The same of the right-hand regenerate were 3.29, 8.42 and 3.00 for the femur, 3.00, 9.14 and 3.00 for the tibia, and 6.42 and 2.40 for the basitarsus for successive phases. It is very interesting to note that the regenerate left-hand mid-leg was almost as long as the regenerate right-hand mid-leg, which had been amputated one phase later than the left-hand leg, in the adult stage.

No. 244 The left-hand fore leg of a newly hatched female larva was amputated from the trochantero-femoral suture. The right-hand fore leg of the same individual was removed from the trochantero-femoral suture just after the first ecdysis. In this case also the regenerate left-hand mid-leg was almost as long as the regenerate right-hand mid-leg, which had been removed one phase later, in the adult stage. It must be noted that in the fourth instar the left-hand regenerate mid-tibia was 2.0 mm in length, while the right-hand regenerate mid-tibia was 4.2 mm in length.

No. 271 The left-hand mid-leg of a female larva was removed from the trochantero-femoral suture just after the first ecdysis. The right-hand mid-leg of the same individual was amputated from the trochantero-femoral suture after the second ecdysis. No regeneration took place on the right-hand lost parts.

No. 276 The right-hand mid-leg of a female larva was removed from the trochantero-femoral suture after the first ecdysis. The left-hand mid-leg of the same individual was removed from the trochantero-femoral suture after the second ecdysis. The regeneration of the left-hand lost leg took place only after the sixth ecdysis.

No. 202 The left-hand hind leg of a female larva was removed from the trochantero-femoral suture after the first ecdysis. The right-hand hind leg of the same insect was amputated from the trochantero-femoral suture just after the second ecdysis. The values of α for the growth of the left-hand regenerate were 1.62, 6.16, 6.57 and 2.18 for the femur, 1.62, 5.41, 7.57 and 2.18 for the tibia, and 6.14 and 0.90 for the basitarsus for successive phases. The same of the right-hand regenerate were 5.66, 8.85 and 2.81 for the femur, and 5.66, 7.71 and 2.72 for the tibia for successive phases.

No. 230 The left-hand hind leg of a female larva was removed from the trochantero-femoral suture after the third ecdysis. The right-hand hind leg of the same insect was amputated from the trochantero-femoral suture just after the fourth ecdysis. The values of α for the growth of the left-hand regenerate were 17.11 and 13.66 for the femur, and 17.11 and 16.00 for the tibia for successive phases. The values of α for the growth of the right-hand regenerate were very large, being 42.66 for the femur and 42.00 for the tibia in the second regenerating phase.

No. 266 The right-hand hind leg of a male larva was removed from the trochantero-femoral suture just after the first ecdysis. The left-hand hind leg of the same individual was amputated from the trochantero-femoral suture just after the second ecdysis. The values of α for the growth of the right-hand regenerate were 7.69, 2.64 and 3.77 for the femur, 7.69, 4.07 and 3.55 for the tibia, and 3.28 and 2.88 for the basitarsus for successive phases. The same of the left-hand regenerate were 7.14 and 6.66 for the femur, and 7.14 and 7.44 for the tibia for successive phases.

No. 272 The left-hand hind leg of a female larva was removed from the trochantero-femoral suture just after the first ecdysis. The right-hand hind leg of the same individual was removed from the trochantero-femoral suture after the third ecdysis. The growth of the regenerate left-hand hind leg was ideal, the values of α being 8.27, 4.33, 2.40 and 1.44 for the femur, and 8.27, 4.50, 2.30 and 1.33 for the tibia for successive phases. The growths of the right-hand regenerate tibia and basitarsus were checked by an unknown reason.

No. 241 The left-hand fore leg of a newly hatched male larva was removed from the trochantero-femoral suture. The right-hand mid-leg of the same individual was removed from the trochantero-femoral suture just after the first ecdysis. The values of α for the growth of the fore regenerate were 6.14, 5.20, 3.37 and 1.50 for the femur, 6.14, 4.60, 4.12 and 2.00 for the tibia, and 6.30, 3.00 and 1.14 for the basitarsus for successive phases. The same of the mid-regenerate were 1.60, 6.75 and 2.35 for the femur, 1.60, 6.75 and 2.21 for the tibia, and 5.00 and 1.21 for the basitarsus for successive phases. The regenerate mid-femur was as long as the normal mid-femur of the opposite side in the adult stage.

No. 265 The left-hand mid-leg of a female larva was removed from the trochantero-femoral suture just after the first ecdysis. The right-hand fore leg of the same insect was removed from the trochantero-femoral suture just after the second ecdysis. The values of α for the growth of the mid-regenerate were 7.00, 4.70, 1.91 and 2.25 for the femur, 7.15, 4.50, 1.91 and 1.75 for the tibia, and 4.50, 1.33 and 1.00 for the basitarsus for successive phases. The same of the fore regenerate were 11.00, 5.00 and

3.75 for the femur, 5.50 for the tibia, and 4.87 for the basitarsus for successive phases.

No. 277 The right-hand fore leg of a female larva was removed from the trochantero-femoral suture after the first ecdysis. The left-hand mid-leg of the same individual was removed from the trochantero-femoral suture after the second ecdysis. The values of α for the growth of the fore regenerate were 5.05, 6.11 and 2.60 for the femur, and 5.05, 5.55 and 3.00 for the tibia for successive phases. The same of the regenerate mid-leg were 6.77, 4.60 and 2.11 for the femur, 10.11, 3.90 and 2.88 for the tibia, 3.10 and 3.33 for the basitarsus for successive phases.

No. 298 Distal 0.8 mm of the left-hand fore femur of a newly hatched male larva was amputated. The left-hand mid-leg of the same individual was removed from the trochantero-femoral suture after the first ecdysis. The growth of the wounded femur was checked by the influence of the regeneration of the lost parts. The femur in question was dropped during the third ecdysis. The values of α for the growth of the regenerate fore leg were 5.41 for the femur and -0.91 for the tibia. The same of the regenerate mid-leg were 4.66, 4.50 and 1.91 for the femur, 4.06, 5.40 and 2.41 for the tibia, 4.50 and 1.66 for the basitarsus for successive phases. The regenerate mid-tibia was almost as long as the normal mid-tibia of the opposite side in the adult stage.

No. 240 The left-hand fore leg of a female larva was removed from the trochantero-femoral suture just after the hatching. The right-hand hind leg of the same individual was amputated from the trochantero-femoral suture just after the first ecdysis. This individual lost its regenerate hind leg in the sixth instar. The values of α for the growth of the fore regenerate were 8.08, 3.92, 3.66, 1.30 and 1.55 for the femur, 7.50, 4.07, 3.66, 1.60 and 1.55 for the tibia, and 3.14, 3.77, -0.60 and 1.88 for the basitarsus for successive phases. The same of the regenerate hind leg were 9.21, 4.77 and 2.40 for the femur, 8.71, 7.11 and 1.30 for the tibia, 5.66 and 1.80 for the basitarsus for successive phases. The growth of the regenerates was ideal, and the regenerate fore leg was almost as long as the normal fore leg of the opposite side in the adult stage. The reason for the depression of the

growth-rate of the regenerate tarsus in the fourth phase was not clear.

No. 245 The left-hand fore leg of a newly hatched female larva was removed from the trochantero-femoral suture, and the right-hand hind leg of the same insect was amputated from the trochantero-femoral suture just after the second ecdysis. The values of α for the growth of the fore regenerate were 5.20, 5.70, 2.00, 1.54 and 1.44 for the femur, 4.06, 6.60, 2.30, 1.63 and 1.77 for the tibia, and 7.40, 2.00, 0.81 and 1.66 for the basitarsus for successive phases. The same of the hind regenerate were 10.00, 3.46, 2.00 and 1.55 for the femur, and 10.00, 3.46, 1.81 and 1.44 for the tibia for successive phases. The regenerate fore tibia apparently surpassed the normal fore tibia of the opposite side in length in the adult stage.

No. 270 The right-hand fore leg of a male larva was removed from the trochantero-femoral suture just after the first ecdysis, and the left-hand hind leg of the same insect was amputated from the same suture after the second ecdysis. No regeneration took place in the lost part of the hind leg at all. The values of α for the growth of the fore regenerate were 8.30, 4.07 and 1.61 for the femur, and 7.30, 5.07 and -2.87 for the tibia. The regenerate tarsus was damaged in the fifth instar, and therefore the growth of the regenerate tibia was highly affected in the fourth regenerating phase.

No. 275 The left-hand fore leg of a male larva was removed from the trochantero-femoral suture after the first ecdysis, and the right-hand hind leg was amputated from the trochantero-femoral suture after the second ecdysis. No regeneration took place in the lost part of the hind leg at all. The values of α for the growth of the regenerate were 8.00, 3.85 and 3.55 for the femur, 6.46, 5.00 and 4.11 for the tibia, 4.35 and 3.33 for the basitarsus for successive phases.

No. 279 Distal 2.0 mm of the left-hand hind femur of a male larva was removed in the second instar. This individual dropped its left-hand fore leg from the trochantero-femoral suture by autotomy in the fourth instar. The growth of the wounded femur was very much influenced by the reconstruction of the lost parts. After the second ecdysis 0.35 mm length of the tibia was regenerated, but the regenerate was diminished in the next instar.

No regeneration was observed in the lost part of the tibia at all.

No. 300 Distal 1.0 mm of the right-hand mid-femur of a newly hatched female larva was removed, and the left-hand fore leg of the same individual was amputated from the trochantero-femoral suture just after the second ecdysis. The growth of the wounded femur was very much checked by the reconstruction of the lost parts in its earlier phases, the values of α being 0.00, -1.61, 1.61, 4.00, 1.60 and 1.00 for successive phases. The bud of the regenerate tibia of the mid-leg appeared after the second ecdysis, and its growth was very rapid, the values of α being 4.69, 4.27, 1.90 and 1.50 for successive phases. The regenerate mid-tibia was as long as the normal mid-tibia of the opposite side in the adult stage.

No. 257 The right-hand mid-leg of a newly hatched female larva was amputated from the trochantero-femoral suture, and the apical part of the regenerate mid-tibia was removed only leaving 0.8 mm of its basal part in the sixth instar. The left-hand mid-leg of the same insect was removed from the trochantero-femoral suture after the first ecdysis, and the regenerate showed a negative growth in the fourth instar, the reason for which still remains unknown. The right-hand fore leg of the same insect was amputated from the trochantero-femoral suture just after the second ecdysis. The values of α for the growth of the right-hand mid-regenerate were 5.62, 3.84, 3.50, 1.81 and 0.50 for the femur, and 5.62, 1.23, 6.90, -7.18 and 0.83 for the tibia for successive phases. The same of the left-hand regenerate were 6.23, -2.00, 8.54 and 1.41 for the femur, and 5.76, -2.40, 9.54 and 1.08 for the tibia respectively. The same of the right-hand fore regenerate were 10.50, 4.63 and 1.91 for the femur, and 9.90, 4.54 and 2.08 for the tibia for successive phases.

No. 232 The right-hand hind leg of a female larva was removed from the trochantero-femoral suture just after the third ecdysis. The fore legs were amputated from the trochantero-femoral suture just after the fourth ecdysis. The values of α for the growth of the hind regenerate were 9.50 and 5.22 for the femur, and 3.00 and 6.00 for the tibia for successive phases. The growth of the regenerate fore legs were very slow or even negative from an unknown reason.

No. 264 The right-hand mid-leg of a newly hatched male

larva was removed from the trochantero-femoral suture. The left-hand hind leg of the same insect was amputated from the suture just after the first ecdysis, and the left-hand fore leg of the same individual was removed from the suture after the second ecdysis. The growth of all the regenerates was ideal, and the regenerate mid-leg was exactly as long as the normal mid-leg of the opposite side in the adult stage. The values of α for the growth of the regenerate hind leg were 7.91, 3.53 and 4.00 for the femur, 7.91, 3.73 and 4.11 for the tibia, 3.66 and 1.66 for the basitarsus for successive phases. The same of the regenerate mid-leg were 4.25, 1.86 and 2.33 for the femur, 4.75, 2.00 and 2.33 for the tibia, 3.33 and 1.13 for the basitarsus for successive phases. The same of the regenerate fore leg were 7.20 and 6.66 for the femur, 7.20 and 6.33 for the tibia respectively.

No. 253 The right-hand mid-leg of a larva was removed from the trochantero-femoral suture just after the hatching. The left-hand hind leg of the same insect was amputated from the suture just after the first ecdysis, and the left-hand fore leg of the same individual was removed from the suture after the second ecdysis. The absolute lengths of the regenerate were 0.25 mm, 1.4 mm and 7.2 mm for the mid-tibia and 0.25 mm, 1.5 mm and 7.0 mm for the mid-femur, 0.3 mm and 0.5 mm for the hind tibia, 0.3 mm and 3.1 mm for the hind femur, 1.5 mm for the fore tibia and 1.8 mm for the femur for successive instars.

No. 254 The left-hand hind leg of a newly hatched male larva was removed from the trochantero-femoral suture. The right-hand fore leg of the same insect was amputated from the suture after the first ecdysis, and the left-hand mid-leg of the same insect was removed from the suture after the second ecdysis. The values of α for the growth of the hind regenerate were 4.50, 4.90, 2.16 and 2.85 for the femur, 4.50, 4.45, 2.50 and 3.00 for the tibia, and 5.45, 1.91 and 0.28 for the basitarsus for successive phases. The same of the mid-regenerate were 9.00 and 6.85 for the femur, 7.58 and 2.42 for the tibia respectively. The same of the fore regenerate were 11.45, 4.75 and 4.14 for the femur, and 10.81, 4.08 and 5.00 for the tibia for successive phases.

No. 262 The left-hand fore leg of a newly hatched male larva was removed from the trochantero-femoral suture. The right-hand hind leg of the same insect was removed from the

suture after the first ecdysis, and the left-hand mid-leg of the same insect was amputated from the suture after the second ecdysis. The values of α for the growth of the regenerate hind leg were 6.25, 5.10 and 2.70 for the femur, 6.25, 5.60 and 2.50 for the tibia, 4.10 and 2.20 for the metatarsus for successive phases. The same of the regenerate mid-leg were 11.10 and 5.00 for the femur, 10.80 and 5.30 for the tibia for successive phases. The same of the regenerate fore leg were 3.18, 2.90 and 2.00 for the femur, 3.75, 2.50 and 2.40 for the tibia, and 3.00, 2.10 and 1.60 for the metatarsus for successive phases.

No. 263 The right-hand mid-leg of a newly hatched male larva was removed from the trochantero-femoral suture. The right-hand hind leg of the same insect was amputated from the suture just after the first ecdysis, and the right-hand fore leg of the same insect was removed from the suture after the second ecdysis. The values of α for the growth of the hind regenerate were 6.92, 4.50 and 3.33 for the femur, 7.14, 4.41 and 3.44 for the tibia, 4.41 and 1.88 for the metatarsus for successive phases. The same of the regenerate mid-leg were 3.64, 1.91 and 2.55 for the femur, 4.00, 2.75 and 1.77 for the tibia, 1.41 and 1.44 for the metatarsus for successive phases. The same of the regenerate fore leg were 9.83 and 5.50 for the femur, 8.33 and 7.44 for the tibia respectively. The regenerate mid-femur was as long as the normal mid-femur of the opposite side in the adult stage, and the regenerate mid-tibia surpassed the normal mid-tibia of the opposite side in length in the adult stage.

No. 251 The right-hand hind leg of a newly hatched male larva was removed from the trochantero-femoral suture. The left-hand fore leg of the same insect was amputated from the trochantero-femoral suture just after the first ecdysis, and the left-hand hind leg of the same individual was removed from the suture after the second ecdysis. The values of α for the growth of the regenerate fore leg were 8.27, 6.00 and 2.70 for the femur, 8.27, 6.00 and 3.00 for the tibia, 5.00 and 2.30 for the basitarsus for successive phases. The same of the right-hand regenerate hind leg were 5.00, 4.63, 3.00 and 2.10 for the femur, 5.00, 5.27, 3.00 and 2.00 for the tibia, and 4.27, 1.30 and 1.70 for the basitarsus for successive phases. The same of the left-hand

regenerate hind leg were 9.90 and 6.20 for the femur, 10.20 and 6.40 for the tibia for successive phases.

No. 256 The left-hand fore leg of a newly hatched larva was removed from the trochantero-femoral suture. The right-hand hind leg of the same insect was amputated from the femur just after the first ecdysis, and the left-hand hind leg was removed from the suture just after the second ecdysis. The values of α for the growth of the regenerate fore leg were 9.75, 3.46, 2.50, 1.40 and 1.11 for the femur, 9.75, 3.13, 2.33, 1.70 and 1.55 for the tibia, and 4.06, 2.50, 0.80 and 0.66 for the basitarsus for successive phases. The same of the regenerate right-hand hind leg were 6.06, 3.91, 2.50 and 1.33 for the femur, 6.06, 4.41, 1.90 and 1.77 for the tibia, and 2.25, 1.90 and 2.11 for the basitarsus for successive phases. The same of the regenerate left-hand hind leg were 9.00, 4.30 and 2.33 for the femur, 1.79, 5.30 and 2.20 for the tibia, 2.50 and 2.11 for the basitarsus for successive phases.

No. 259 The right-hand hind leg of a newly hatched male larva was removed from the trochantero-femoral suture. The left-hand fore leg of the same insect was amputated from the trochantero-femoral suture after the first ecdysis, and the left-hand hind leg was removed from the suture after the second ecdysis. The values of α for the growth of the regenerate right-hand hind leg were 6.00, 4.14, 2.16 and 3.14 for the femur, 6.25, 3.92, 2.50 and 3.14 for the tibia, and 5.00, 0.83 and 2.42 for the basitarsus for successive phases. The same of the regenerate left-hand hind leg were 9.25 and 7.85 for the femur, 9.83 and 7.57 for the tibia for successive phases. The regenerate fore leg was dropped by autotomy in the fourth instar.

No. 260 The right-hand hind leg of a newly hatched female larva was removed from the trochantero-femoral suture. The left-hand fore leg of the same individual was amputated from the trochantero-femoral suture just after the first ecdysis, and the left-hand hind leg of the same insect was removed from the suture after the second ecdysis. The values of α for the growth of the regenerate fore leg were 10.90, 4.63, 2.09 and 2.33 for the femur, 8.27, 3.18, 2.00 and 3.33 for the tibia for successive phases. The same of the regenerate right-hand hind leg were 5.18, 1.90, 1.09 and 1.83 for the femur, 5.45, 1.90, 1.36 and 1.66 for the tibia, and 4.36, 0.72, 0.45 and 2.33 for the basitarsus for successive phases.

The same of the regenerate left-hand hind leg were 8.63, 5.18 and 3.83 for the femur, 9.00, 5.36 and 3.16 for the tibia, 3.90 and 1.16 for the basitarsus for successive phases.

No. 299 Distal 2.2 mm of the right-hand fore femur of a newly hatched female larva was removed by amputation. The hind legs of the same individual were amputated from the trochantero-femoral suture just after the second ecdysis. The growths of the regenerate fore femur and tibia were at first very much checked owing to the regeneration of the lost parts. The values of α for the regenerate fore leg were -1.04, 2.50, 2.91, 1.72, 2.10 and 1.18 for the femur, and -0.83, 4.45, 3.80 and 2.27 for the tibia for successive phases. The values of α for the regenerate left-hand hind leg were 7.81, 3.10 and 1.81 for the femur, and 0.81, 3.10 and 0.63 for the tibia, and the same of the right-hand hind leg were 9.81, 4.80 and 2.00 for the femur, and 9.81, 4.80 and 2.00 for the tibia for successive phases.

No. 205 The left-hand mid-leg of a male larva was amputated from the trochantero-femoral suture just after the first ecdysis, and the left-hand hind leg of the same insect was removed from the trochantero-femoral suture just after the second ecdysis. The values of α for the growth of the regenerate mid-leg were 7.46, 4.20 and 3.70 for the femur, and 6.69, 1.30 and 4.70 for the tibia for successive phases. The same of the regenerate hind leg were 10.20 and 5.60 for the femur, 10.25 and 5.90 for the tibia, and 4.60 for the metatarsus for successive phases.

No. 231 The right-hand mid-leg and the left-hand hind leg of a female larva were removed from the trochantero-femoral suture just after the fourth ecdysis. This insect died during the sixth ecdysis. The absolute lengths of the regenerates were 0.25 mm for the mid-tibia, 0.25 mm for the mid-femur, 1.8 mm for the hind tibia and 1.5 mm for the hind femur.

No. 243 The right-hand hind leg of a newly hatched male larva was removed from the trochantero-femoral suture. The left-hand mid-leg of the same insect was amputated from the trochantero-femoral suture just after the first ecdysis. The regenerate mid-leg was almost as long as the normal mid-leg of the opposite side in the adult stage. The values of α for the growth of the regenerate mid-leg were 10.41, 5.27 and 3.11 for the femur, and 10.25, 5.45 and 3.00 for the tibia for successive phases. The

same of the regenerate hind leg were 6.66, 5.33, 2.81 and 2.44 for the femur, 6.66, 4.75, 3.27 and 2.77 for the tibia, and 4.75, 1.90 and 1.22 for the basitarsus for successive phases.

No. 247 The left-hand mid-leg of a newly hatched female larva was removed from the trochantero-femoral suture, and the right-hand hind leg of the same insect was amputated from the trochantero-femoral suture just after the first ecdysis. The values of α for the growth of the regenerate mid-leg were 6.00, 4.76, 1.38, 1.88 and 1.44 for the femur, 6.00, 4.76, 1.77 and 1.33 for the tibia, and 3.69, 0.61, 0.55 and 1.88 for the metatarsus for successive phases. The same of the regenerate hind leg were 0.53, 4.15 and 7.00 for the femur, and 0.53, 3.00 and 7.66 for the tibia for successive phases. It is very interesting that the growth of the regenerated hind leg was gradually becoming rapid towards the end of the larval development. The regenerate mid-femur was as long as the normal mid-leg in the adult stage. The regenerate mid-tibia surpassed the normal mid-tibia in the adult stage.

No. 249 The left-hand hind leg of a newly hatched larva was removed from the trochantero-femoral suture. The right-hand mid-leg of the same insect was dropped by autotomy after the first ecdysis, the right-hand hind leg was dropped by autotomy after the second ecdysis, and further the left-hand fore leg was amputated from the suture after the third ecdysis. The values of α for the growth of the regenerates were 14.00, 1.20 and 1.40 for the left-hand hind femur, 13.69, 1.20 and 1.60 for the left-hand hind tibia, 1.40 and 0.00 for the left-hand basitarsus, 5.84, 5.40 and 2.50 for the right-hand mid-femur, 5.84, 5.50 and 2.40 for the right-hand mid-tibia, 4.10 and 1.30 for the right-hand basitarsus, 5.00 and 5.60 for the right-hand hind femur, 4.00 and 2.50 for the right-hand hind tibia, 6.00 for the left-hand fore femur, and 6.40 for the left-hand fore tibia for successive phases.

No. 267 The right-hand mid-leg of a female larva was removed from the trochantero-femoral suture after the first ecdysis. The left-hand hind leg of the same individual was dropped by autotomy after the second ecdysis. The values of α for the growth of the regenerates were 7.80, 3.85, 2.66 and 1.88 for the mid-femur, 6.80, 4.42, 2.55 and 1.66 for the mid-tibia, 2.21, 2.77 and 1.00 for the mid-basitarsus, 3.21, 8.44 and 3.77 for the hind femur, 2.92, 7.55 and 3.33 for the hind tibia for successive phases.

No. 268 . The left-hand mid-leg of a male larva was removed from the trochantero-femoral suture just after the first ecdysis, and the right-hand hind leg was dropped by autotomy after the second ecdysis. The bud of the hind regenerate appeared in the fifth ecdysis. The values of α for the growth of the regenerates were 5.16 for the mid-femur, 7.75 for the mid-tibia, 9.10 for the hind femur, and 9.10 for the hind tibia. The mid-legs were dropped by autotomy in the fifth ecdysis.

No. 269 The right-hand mid-leg of a male larva was amputated from the trochantero-femoral suture after the second ecdysis, and the right-hand hind leg of the same individual was dropped by autotomy in the third ecdysis. The bud of the hind regenerate appeared just after the fourth ecdysis. The growth of the regenerate hind tibia was greatly checked by the reconstruction of the tarsus. The values of α for the growth of the regenerates were 4.83 and 2.50 for the mid-femur, 4.25 and 2.80 for the mid-tibia, 3.25 and 2.10 for the mid-basitarsus, 3.00 for the hind femur, and -1.40 for the hind tibia for successive phases.

No. 274 The right-hand mid-leg of a female larva was removed from the trochantero-femoral suture just after the first ecdysis, and the left-hand hind leg was dropped by autotomy just after the second ecdysis. The values of α for the growth of the regenerates were 9.09, 4.27, 2.27 and 1.50 for the mid-femur, 9.09, 4.27, 2.09 and 1.75 for the mid-tibia, 3.81, 1.72 and 0.50 for the mid-basitarsus, 7.00, 6.27 and 4.25 for the hind femur, 7.36 and 4.50 for the hind tibia for successive phases.

No. 200 The left-hand mid-leg of a female larva was removed from the trochantero-femoral suture just after the first ecdysis, the right-hand hind leg was dropped by autotomy in the second instar, and the left-hand hind leg was dropped by autotomy after the second ecdysis. The values of α for the growth of the regenerates were 7.91, 3.58, 2.87 and 1.16 for the mid-femur, 7.58, 1.66, 3.87 and 1.91 for the mid-tibia, 1.75, 6.16, 7.00 and 2.00 for the right-hand hind femur, 1.75, 5.83, 6.75 and 1.81 for the right-hand hind tibia, 4.87 and 1.33 for the right-hand hind basitarsus, 3.75, 7.25 and 4.08 for the left-hand hind femur, 3.75, 7.87 and 3.16 for the left-hand hind tibia, 5.62 and 2.50 for the left-hand hind basitarsus for successive phases.

No. 252 The left-hand hind leg of a newly hatched female

larva was removed from the trochantero-femoral suture, the right-hand hind leg of the same insect was dropped by autotomy after the first ecdysis, and the left-hand mid-leg of the same insect was dropped by autotomy just after the second ecdysis. The growth of the regenerates was normal, the values of α being 9.72, 4.90 and 1.72 for the mid-femur, 9.31, 4.50 and 2.20 for the mid-tibia, 3.00 and 1.54 for the mid-basitarsus, 8.80, 3.00, 2.45, 1.50 and 1.09 for the left-hand hind femur, 8.60, 3.50, 2.36, 1.40 and 0.81 for the left-hand hind tibia, 4.78, 4.36, 2.30 and 1.36 for the right-hand hind femur, 4.50, 5.27, 1.90 and 1.27 for the right-hand hind tibia, and 4.36, 1.80 and 0.27 for the right-hand hind basitarsus for successive phases.

No. 255 The right-hand hind leg of a newly hatched female larva was removed from the trochantero-femoral suture, the left-hand hind leg of the same insect was dropped by autotomy just after the first ecdysis, and the right-hand mid-leg of the same individual was dropped by autotomy after the second ecdysis. The values of α for the growth of the regenerates were 7.83, 5.44 and 2.30 for the mid-femur, 7.58, 5.77 and 2.10 for the mid-tibia, 6.44 and 1.20 for the mid-basitarsus, 6.80, 5.27, 2.41, 1.44 and 1.30 for the right-hand hind femur, 7.80, 4.72, 2.41, 1.22 and 1.40 for the right-hand hind tibia, 6.36, 1.08, 0.88 and 0.80 for the right-hand hind basitarsus, 8.27, 4.50, 2.22 and 1.30 for the left-hand hind femur, 8.27, 4.66, 2.00 and 1.30 for the left-hand hind tibia, and 4.00, 1.44 and 1.10 for the left-hand hind basitarsus for successive phases.

No. 233 The mid-legs and the right-hand hind leg of a larva detached by autotomy just after the fourth ecdysis. In this individual, no regeneration took place in the lost part of the hind leg.

No. 250 The left-hand mid-leg of a newly hatched female larva was removed from the trochantero-femoral suture. The right-hand mid-leg was removed by autotomy just after the first ecdysis, and the left-hand hind leg of the same individual was dropped by autotomy just after the second ecdysis. The values of α for the growth of the regenerates were 5.35, 3.61, 1.64, 2.00 and 1.00 for the left-hand mid-femur, 4.35, 4.07, 2.14, 1.62 and 1.18 for the left-hand mid-tibia, 4.07, 1.00, 1.65 and 0.45 for the left-hand mid-basitarsus, 7.69, 3.35, 2.75 and 1.09 for the right-hand

mid-femur, 7.69, 3.14, 2.62 and 1.27 for the right-hand mid-tibia, 2.64, 1.62 and 0.45 for the right-hand mid-basitarsus, 6.50, 6.37 and 2.90 for the hind femur, and 6.50, 4.87 and 2.54 for the hind tibia for successive phases.

No. 258 The right-hand hind leg of a newly hatched male larva was removed from the trochantero-femoral suture. The left-hand mid-leg of the same insect detached by autotomy after the first ecdysis, and the right-hand mid-leg was dropped also by autotomy just after the second ecdysis. The values of α for the growth of the regenerates were 7.16, 2.93, 3.40 and 2.40 for the hind tibia, 3.18, 1.90 and 1.70 for the hind basitarsus, 7.18, 5.70 and 2.60 for the left-hand mid-leg, 7.05, 6.00 and 3.00 for the left-hand mid-tibia, 4.80 and 2.20 for the left-hand mid-metatarsus, 11.00 and 5.50 for the right-hand mid-femur, 10.80 and 6.00 for the right-hand mid-tibia for successive phases.

No. 261 The left-hand mid-leg of a newly hatched male larva was removed from the trochantero-femoral suture. The right-hand mid-leg of the same individual was dropped by autotomy just after the first ecdysis, and the left-hand hind leg detached by autotomy after the second ecdysis. The values of α for the growth of the regenerate were 4.16, 2.27 and 2.27 for the left-hand mid-femur, 4.41, 2.54 and 1.90 for the left-hand mid-tibia, 3.50, 1.72 and 1.27 for the left-hand mid-basitarsus, 7.58, 4.81 and 2.18 for the right-hand mid-femur, 7.58, 4.72 and 2.63 for the right-hand mid-tibia, 3.36 and 2.45 for the right-hand mid-basitarsus, 9.81 and 4.81 for the hind femur, 9.81 and 5.09 for the hind tibia for successive phases.

Additional Experiments

No. 219 The left-hand mid-leg and the left-hand hind leg of a male larva detached by autotomy after the second ecdysis. The values of α for the growth of the regenerates were 5.22 and 4.09 for the mid-femur, 6.66 and 4.63 for the mid-tibia, 4.55 and 0.18 for the hind femur, 4.44 and 3.10 for the hind tibia for successive phases. In the fifth instar a part of the regenerate hind femur was wounded, and this affected the growth of the femur in question, which remained only 1.9 mm in length in the next instar.

No. 235 The left-hand fore leg of a female larva was dropped by autotomy after the fifth ecdysis. The bud of the regenerate appeared after the sixth ecdysis. The values of α for the growth of the regenerate parts were 4.50 for the femur, and 3.00 for the tibia for the second phase of the regeneration.

No. 248 The right-hand mid-leg of a newly hatched female larva was removed from the trochantero-femoral suture, and the left-hand mid-leg of the same individual was dropped by autotomy after the first ecdysis. The regenerate right-hand mid-leg was dropped in the sixth instar. The growth of the regenerate right-hand mid-femur was abnormal. The values of α for the growth of the regenerates were 3.62, 1.75 and 1.25 for the left-hand mid-femur, 3.78, 1.25 and 1.62 for the left-hand mid-tibia, 3.81, 0.50 and 0.00 for the left-hand mid-basitarsus, 1.06 and -0.25 for the right-hand mid-femur, 1.68 and 1.91 for the right-hand mid-tibia, 1.06 and 1.08 for the right-hand mid-metatarsus for successive phases.

No. 39 The right-hand antenna of a male larva was amputated from the fourth segment after the first ecdysis. The absolute lengths of the regenerate antenna were 1.4 mm, 2.3 mm, 2.5 mm, 7.0 mm and 1.30 mm for successive instars. The values of α for the growth of the regenerate were 1.46, 2.25, 2.50 and 2.70 for successive phases. The growth curve of the regenerate was not similar to that of No. 7. The absolute lengths of the left-hand normal antenna were 12.0 mm, 17.0 mm, 2.30 mm, 33.0 mm and 47.7 mm for successive instars.

No. 64 The left-hand antenna of a larva was amputated from the fifth segment after the first ecdysis. The absolute lengths of the normal antenna were 11.1 mm, 16.0 mm, 2.20 mm and 30.5 mm for successive instars, and the same of the regenerate antenna were 0.9 mm, 1.1 mm, 1.6 mm and 3.0 mm for successive stages. The growth curve of the regenerate was similar to that of No. 39.

No. 65 The right-hand hind tarsus of a male larva was removed from the base just after the first ecdysis. The bud of the regenerate tarsus appeared after the second ecdysis, and the tetramerous tarsus was regenerated after the third ecdysis. The absolute lengths of the regenerate tarsus were 0.35 mm, 0.75 mm,

1.50 mm and 3.0 mm for successive instars. The growth of the basitarsus was slower than that of the distal part.

No. 70 The left-hand antenna of a male larva was amputated at the middle portion just after the first ecdysis. The absolute lengths of the regenerate antenna were 5.9 mm (second instar), 8.0 mm (third), 21.0 mm (fifth) and 31.0 mm (sixth), and the same of the normal antenna were 11.9 mm (second), 16.4 mm (third), 31.0 mm (fifth) respectively.

No. 84 The left-hand hind tarsus of a female larva was removed from the base after the first ecdysis. After the fourth ecdysis a three-segmented tarsus was regenerated, and in the next instar it became tetramerous. The absolute lengths of the regenerate were 0.35 mm, 0.75 mm and 1.00 mm for the basitarsus, 0.5 mm and 2.10 mm for the remaining parts for successive phases. The growth of the leg with a wounded tarsus was slightly affected by the reconstruction of the tarsus.

No. 85 The right-hand fore tarsus of a female larva was removed from the base just after the third ecdysis. In the fifth instar the bud of the regenerate tarsus appeared. In the next instar the tetramerous tarsus appeared. The absolute lengths of the regenerate were 1.25 mm and 2.0 mm for the basitarsus, 1.25 mm and 1.8 mm for the remaining parts for successive phases.

No. 7 The right-hand antenna of a female larva was amputated from the fourth segment after the first ecdysis. The absolute lengths of the normal antenna were 11.5 mm (second instar), 16.0 mm (third), 22.5 mm (fourth), and 31.0 mm (fifth), and the same of the regenerate antenna were 0.3 mm (second), 1.5 mm (third), 3.0 mm (fourth), and 4.5 mm (fifth) respectively. The growth of the regenerate antenna was ideal, and the curve was quite similar to that of the regenerate leg. The values of α varied from 6.36, 2.50 to 1.20 for successive phases. This individual died in the fifth instar.

No. 8 The left-hand antenna of a newly hatched female larva was amputated from the fourth segment. The absolute lengths of the normal antenna were 12.0 mm (second instar), 16.7 mm (third), 21.0 mm (fourth), 28.7 mm (fifth) and 37.0 mm (sixth), and the same of the regenerate were 0.25 mm (second), 1.4 mm (third), 2.25 mm (fourth), 3.5 mm (fifth) and 5.9 mm (sixth) respectively. The growth of the regenerate antenna was very much

like that of the individual No. 7, the values of α being 5.35, 3.00, 1.46 and 1.76 for successive phases. This material died in the sixth instar.

No. 18 Distal 4.4 mm of the right-hand antenna of a newly hatched male larva was removed by amputation. The absolute lengths of the normal antenna were 7.5 mm (first instar), 11.4 mm (second), 17.0 mm (third), 23.4 mm (fourth) and 33.0 mm (fifth), and the same of the regenerate antenna were 3.1 mm (first), 5.5 mm (second), 9.5 mm (third), 16.0 mm (fourth) and 26.0 mm (fifth) respectively. The growth of the regenerate antenna was not rapid.

No. 19 Distal 3.9 mm of the left-hand antenna of a newly hatched male larva was removed by amputation. The absolute lengths of the normal antenna were 8.1 mm (first instar), 12.3 mm (second), 17.0 mm (third), 21.9 mm (fourth), 29.0 mm (fifth) and 39.0 mm (sixth), and the same of the regenerate antenna were 4.2 mm (first), 6.0 mm (second), 9.3 mm (third), 14.5 mm (fourth), 23.0 mm (fifth) and 32.0 mm (sixth) respectively. The growth of the regenerate was as slow as in the material No. 18. This material died in the sixth instar.

No. 27 The right-hand hind tarsus of a male larva was removed in the third instar. In the fourth instar a bud of the regenerate appeared. The absolute lengths of the regenerate were 1.0 mm (fourth instar), 2.5 mm (fifth) and 4.25 mm (sixth), and the same of the basitarsus were 1.0 mm (fifth) and 2.25 mm (sixth), while those of the remaining parts were 1.5 mm (fifth) and 2.0 mm (sixth) for successive instars. The growth of the regenerate basitarsus was more rapid than in those of the remaining parts.

No. 50 Distal 4.75 mm of the right-hand antenna of a larva was removed in the first ecdysis. The absolute lengths of the normal antenna were 8.0 mm (first instar), 12.0 mm (second), 15.0 mm (third), 21.2 mm (fourth) and 28.0 mm (fifth), and the same of the regenerate antenna were 3.25 mm (first), 5.0 mm (second), 8.2 mm (third), 14.0 mm (fourth) and 20.8 mm (fifth) for successive instars. The growth of the regenerate was similar to that of No. 19. This individual died in the fifth instar.

No. 57 b The right-hand mid-leg of a male larva was removed in the third ecdysis. In the next instar the regenerate femur appeared. The growth of the regenerate was fairly rapid, the values of α being 2.07 and 2.27 for successive phases. After

the fifth ecdysis a very small tibia and a tetramerous tarsus appeared.

No. 60 b Distal 14.8 mm of the right-hand antenna of a male larva was removed in the third instar. The absolute lengths of the normal antenna were 16.8 mm (third instar), 34.0 mm (fifth) and 54.0 mm (sixth), and the same of the regenerate antenna were 2.0 mm (third), 5.9 mm (fifth) and 11.2 mm (sixth) for successive instars.

No. 61 b Two antennae of a female larva were removed in the third instar. The absolute lengths of the left-hand regenerate antenna were 2.0 mm (third instar), 4.0 mm (fifth) and 6.0 mm (sixth), and the same of the right-hand regenerate antenna were 1.8 mm (third), 4.0 mm (fifth) and 5.8 mm (sixth) for successive instars. This individual died in the sixth instar.

No. 81 Distal 5.1 mm of the right-hand hind tibia of a female larva was removed in the fourth instar. The growth of the wounded tibia was like that of the regenerate antenna of No. 19. In the fifth instar the basitarsus (0.5 mm length) appeared. In the sixth instar a tetramerous tarsus was regenerated.

E. Discussions

1. Historical

The regeneration in general, the growth of the regenerating appendages and the regeneration as a function of time are well covered by the works of FURUKAWA (1935), RICHARDS (1937), PAULIAN (1938) and WOODRUFF (1939), so far as the insects are concerned. The following are summarized results of those authors and others with regard to some important points which have a close connection with my study. Regeneration is distinct from embryonic regulation. It is intimately associated with growth, and the onset of the capacity for regeneration is connected with the onset of the capacity for growth. Regeneration other than mere wound healing is usually possible only at the time of ecdysis. The produced part becomes more nearly perfect with subsequent moultings. Regenerative power is to a considerable degree a function of age and the degree of regeneration is inversely proportional to the age of the insect. The regenerated

Table 8. Length measurements of *Phraortes kumamotoensis* at different instars of growth. In millimetres.

Meso.: Mesonotum Meta.: Metanotum L.: Left-hand R.: Right-hand B.: Body																
No.	Instar	Fore legs				Mid-legs				Hind legs						
		Tibia		Femur		Tibia		Femur		Tibia		Femur				
		L	R	L	R	L	R	L	R	L	R	L	R			
1	I	3.9	0.0	3.4	0.0	3.0	3.0	3.0	3.0	3.5	3.75	3.45	3.45	3.25	2.25	19.2
	II	5.2	0.6	5.6	0.6	4.5	4.5	4.6	4.6	5.5	5.6	5.0	5.0	5.1	3.2	26.0
	III	7.0	1.25	8.0	1.25	6.5	6.3	6.0	6.2	7.3	7.3	7.2	7.2	6.9	4.0	34.0
2	I	0.0	3.4	0.0	3.75	3.0	3.0	3.0	3.3	3.6	3.7	3.25	3.25	2.80		17.3
	II	0.35	5.4	0.35	5.4	0.0	4.6	0.0	4.5	4.6	5.4	5.0	5.0			24.9
	III	1.5	8.0	1.75	8.2	0.5	6.0	0.5	6.3	7.5	7.6	6.9	6.9	7.0	5.0	34.5
	IV													10.0	6.8	
3	V	7.5	12.4	9.6	13.2	6.0	9.8	6.0	9.0	3.0	8.0	3.0	10.2	10.0	6.8	53.0
	VI	13.5	16.5	11.6	16.0	9.0	11.5	9.0	11.9	9.0	11.0	8.0	13.0	12.5	8.8	65.0
	VII	17.0	20.5	17.8	21.0	12.0	14.5	12.1	14.9	13.8	15.5	13.0	16.5	15.8	10.20	80.0
	I	3.4	3.5	3.75	3.5	3.0	0.0	3.0	0.0	3.5	3.6	3.25	3.25	3.0	2.0	19.0
4	II	5.1	5.1	5.6	5.7	4.2	0.2	4.4	0.2	5.5	5.5	5.0	5.0	5.0	3.2	26.0
	III	7.2	7.2	8.0	8.0	6.4	1.25	6.2	1.15	7.4	7.5	7.0	7.0	7.0	5.0	34.5
	IV	9.5	9.6	10.6	10.9	7.8	1.6	8.0	2.7	8.8	9.2	8.3	8.4	8.5	5.4	44.0
	V	13.0	13.0	13.0	13.0	10.0	3.6	10.2	6.1	11.5	11.3	10.8	10.8	11.1	7.4	58.0
	VI	17.0	17.0	16.5	16.5	12.6	9.0	13.1	9.6	14.0	14.3	14.1	14.6	14.2	10.0	73.5
	VII	22.0	22.1	21.0	21.0	15.9	13.9	16.0	13.5	18.5	18.8	17.8	18.3	18.0	12.0	85.0

4	I	3.4	3.3	3.65	3.65	0.0	3.1	50.0	3.0	3.75	3.75	3.45	3.40	2.95	2.0	18.8
	II	5.2	5.5	5.9	5.9	0.4	4.2	0.4	4.4	5.7	5.6	5.2	5.0	4.9	3.2	25.8
	III	7.5	7.5	8.0	8.0	0.9	6.0	1.3	6.2	8.0	8.0	7.0	7.0	6.9	4.8	35.0
	IV	9.5	9.5	10.8	10.4	1.75	7.6	3.75	8.0	9.9	9.8	8.9	8.9	8.0	5.4	44.0
	V	13.0	12.4	13.9	13.0	3.9	9.5	7.0	10.0	12.7	12.7	11.0	11.0	10.5	7.5	57.0
	VI	16.8	16.5	17.0	16.0	8.0	12.1	10.0	12.0	15.0	15.0	14.4	14.4	13.0	9.0	71.0
	VII	21.8	21.8	20.5	20.5	13.0	15.0	13.5	15.0	20.0	20.0	18.5	18.5	16.0	10.6	82.5
5	I	3.15	3.15	3.5	3.5	2.75	2.75	3.0	2.75	3.4	0.0	3.0	0.0	2.98	1.85	18.5
	II	5.0	5.0	5.5	5.5	4.5	4.5	4.2	4.2	5.2	0.4	4.5	0.4	4.6	3.0	25.0
	III	7.4	7.3	8.0	7.8	6.0	6.0	6.0	6.0	7.0	1.4	7.0	1.4	7.0	4.6	35.0
	IV	9.5	9.5	10.4	10.4	8.0	7.8	7.8	7.8	8.6	4.0	8.2	4.0	8.0	5.5	44.0
	V	12.0	12.4	13.0	12.6	9.2	9.9	10.0	9.4	11.8	8.0	10.2	8.0	10.8	7.0	55.8
	VI	16.0	16.0	16.0	16.0	12.0	12.0	12.3	12.3	14.3	11.5	13.5	11.4	13.7	9.9	71.5
	VII	21.2	21.2	22.0	22.0	16.2	16.2	16.9	16.9	14.0	19.5	14.0	18.6	17.2	11.0	82.0
6	I	3.5	3.5	3.55	3.55	3.0	3.0	3.25	3.25	0.0	3.3	0.0	3.3	3.0	2.0	18.0
	II	5.0	5.0	6.0	5.5	4.5	4.5	4.5	4.6	0.4	5.1	0.4	5.1	4.6	3.0	25.0
	III	7.5	7.5	7.9	7.9	6.4	6.4	6.9	6.8	1.3	7.2	1.4	7.5	7.0	4.5	35.0
	IV	9.0	9.0	10.2	10.0	7.6	7.2	7.8	7.8	2.0	9.0	3.4	8.4	8.0	5.4	44.0
	V	12.0	12.0	13.5	13.5	10.0	10.0	10.5	10.5	5.0	11.7	6.9	11.0	11.2	6.5	55.6
	VI	16.0	16.0	17.5	17.5	12.6	12.6	13.2	13.2	9.5	14.9	10.0	14.0	14.0	9.5	72.0
	VII	21.2	21.2	22.0	22.0	16.2	16.2	16.9	16.9	14.0	19.5	14.0	18.6	17.2	11.0	82.0
7	I	3.2	3.2	3.8	3.7	2.9	2.9	2.9	3.1	3.65	3.6	3.25	3.15	3.1	1.9	17.3
	II	5.0	5.0	6.0	5.2	4.7	4.5	4.3	4.5	5.4	5.4	5.2	5.5	5.0	3.0	24.5
	III	7.2	7.0	7.9	7.9	6.0	6.1	6.0	6.2	7.2	7.2	7.0	7.0	6.5	4.3	34.0
	IV	9.9	9.9	10.8	10.3	7.9	7.9	8.0	8.0	9.5	9.9	9.0	9.0	8.4	5.8	43.8
	V	13.9	13.9	14.8	14.8	11.0	11.0	11.0	11.0	13.5	13.5	12.5	12.5	11.8	7.4	56.0

8	I	3.25	3.25	3.7	3.75	3.0	3.0	3.0	3.0	3.75	3.50	3.4	3.0	3.25	2.0	19.0
	II	5.0	5.1	5.7	5.7	4.6	4.5	4.7	4.5	5.6	5.5	5.0	5.0	5.1	3.2	25.4
	III	7.0	7.0	8.0	8.0	6.3	6.3	6.2	6.2	8.0	7.8	6.8	6.8	7.0	4.5	34.0
	IV	9.0	9.0	10.0	10.0	8.0	7.6	7.7	7.8	8.9	9.0	8.2	8.5	8.2	5.3	43.0
	V	12.0	12.3	12.8	13.0	10.2	10.0	10.1	10.1	11.5	11.6	11.0	11.0	11.0	7.5	57.0
	VI	15.6	15.6	17.0	17.5	12.2	12.2	13.0	13.0	14.2	14.2	14.0	14.0	15.1	10.5	76.0
10	I	3.25	3.25	3.75	3.5	2.85	3.0	3.0	2.9	0.0	0.0	0.0	0.0	3.4	1.9	18.1
	II	4.8	5.0	5.5	5.4	4.2	4.2	4.2	4.2	0.5	0.5	0.5	0.5	5.0	3.0	25.5
	III	6.5	6.5	7.5	7.4	6.0	6.0	5.9	5.9	1.5	1.5	1.75	1.7	6.4	4.0	35.0
	IV															
	V	12.0	12.0	12.2	12.2	9.5	9.5	9.5	9.5	3.0	9.0	5.1	9.9	10.0	7.5	55.0
	VI	16.0	16.0	15.5	15.5	11.1	11.1	11.8	11.8	9.5	12.3	9.0	12.2	13.4	9.2	70.0
11	VII	19.1	20.0	19.4	19.4	14.0	14.0	14.5	14.5	16.0	17.0	12.8	16.1	16.8	11.0	84.0
	I	3.25	3.4	3.75	3.7	2.75	2.75	3.0	2.7	3.6	3.75	3.25	3.25	3.1	2.0	18.0
	II	5.0	5.0	5.5	5.6	4.5	4.5	4.5	4.5	5.4	5.3	5.0	5.0	5.0*	3.0	25.0
	III	7.2	7.2	8.0	8.0	6.0	6.0	6.0	6.0	7.0	7.0	6.5	7.0	6.5	4.0	33.0
	IV	8.8		10.0		7.0	7.0	7.7	7.0	8.6	8.2	8.3	8.2	8.0	5.0	42.0
	V	12.0	1.5	12.5	2.0	9.6	9.5	9.5	9.5	11.2	11.2	11.0	11.0	11.0	7.2	55.0
12	VI	16.0	7.0	17.0	7.8	11.9	11.9	12.5	12.5	14.0	14.0	14.2	14.2	14.0	9.3	70.0
	VII	20.0	14.0	20.5	13.0	14.5	14.5	15.2	15.2	17.9	17.2	17.8	17.8	17.2	11.4	83.0
	I	3.25	0.0	3.35	1.9	2.9	2.75	2.7	2.75	3.6	3.4	3.0	3.0	2.75	1.75	17.0
	II	5.0	0.0	5.2	1.3	4.3	4.5	4.3	4.4	5.5	5.3	5.0	5.0	4.8	2.9	24.0
	III	7.5	0.5	8.5	1.75	6.5	6.2	6.0	6.4	7.4	7.4	7.0	7.0	7.0	4.5	35.0
	IV	10.2	0.5	10.9	3.0	8.0	8.0	8.0	8.0	9.5	9.5	9.3	9.3	9.0	5.0	45.0
12	V	15.2	2.5	14.8	6.5	10.8	10.8	10.0	10.0	13.0	13.0	12.0	12.0	12.0	8.0	60.0
	VI	23.0	6.8	21.1	12.0	15.2	15.2	16.0	16.0	19.0	19.0	18.0	18.0	15.5	10.1	71.0

13	I	0.0	3.25	1.70	3.5	2.85	2.9	3.0	2.9	3.75	3.75	3.2	3.0	3.1	2.0	19.0
	II	0.0	5.2	1.5	5.6	4.4	5.0	4.5	4.5	6.2	5.9	5.2	5.0	5.1	3.6	26.5
	III	0.5	7.6	1.0	8.0	6.5	6.5	6.0	6.0	8.5	8.2	7.0	7.0	6.5	4.5	34.0
	IV	0.0	10.8	2.2	10.5	8.0	8.5	8.0	8.0	10.2	10.0	9.2	9.2	8.4	5.6	44.5
	V		14.0	5.0	13.5	10.5	11.0	10.6	10.6	13.0	13.0	11.8	11.8	11.5	8.0	57.5
	VI		18.2	9.1	17.8	13.6	13.6	13.5	13.5	17.0	17.0	15.5	15.5	14.5	10.1	74.0
VII.				12.8	22.9									18.0		
14	I	3.5	3.5	3.9	3.8	3.25		3.1	1.5	3.95	3.8	3.3	3.3	3.0	2.0	19.5
	II	5.1	5.1	5.0	5.0	5.0	0.0	5.0	1.5	6.0	5.6	5.0	5.0	5.2	3.1	27.0
	III	7.8	7.8	8.0	8.0	6.2	0.5	6.2	1.0	8.0	7.6	7.0	7.0	7.0	5.0	36.0
	IV	9.9	9.9	10.2	10.2	7.9		8.0	1.9	9.1	9.1	8.5	8.5	8.6	6.0	45.0
	V	12.2	12.2	13.0	13.0	10.4		10.5	2.75	12.0	11.0	10.9	11.0	11.5	7.5	59.0
	VI	15.5	15.5	17.0	17.0	12.5		13.0	6.0	14.5	14.5	14.0	14.0	14.1	10.0	71.0
	VII	19.8	19.8	19.8	19.8	14.3		15.0	10.0	17.5	17.0	16.5	17.0	16.8	11.0	81.0
15	I															
	II	5.0	5.0	5.9	5.9	0.15	5.0	0.15	5.0	5.5	5.8	5.5	5.0	5.5	3.2	28.0
	III	7.2	7.8	8.0	8.2	0.75	6.5	0.75	6.0	8.0	8.0	7.5	7.5	7.2	5.0	36.5
	IV	9.3	0.0	10.1	6.9	2.0	8.9	2.8	8.9	10.1	10.1	9.9	9.9	9.9	6.2	47.0
	V	13.9		14.0	7.2	8.0	11.6	8.0	11.5	14.0	14.1	13.0	13.0	12.5	8.0	61.0
	VI	20.8		20.0	9.0	15.0	18.0	15.0	17.0	20.0		18.5		14.0	9.0	67.0
16	I	3.4	3.35	3.5	3.65	3.15	3.0	2.75	2.9	0.0	3.75	1.6	3.2	3.1	2.0	18.1
	II	5.1	5.1	5.5	5.5	4.4	4.4	4.1	4.1	2.1	0.0	4.6	0.5	4.6	3.0	23.5
	III	6.0	6.0	6.7	6.7	5.5	5.5	5.1	5.1	6.6	0.9	5.9	1.0	5.8	3.4	29.0

17	I	3.35	3.35	3.85	3.8	2.9	3.0	3.0	3.05	0.0	4.0	1.5	3.15	3.25	2.15	19.6
	II	5.0	5.0	6.0	6.0	4.5	4.5	5.0	5.0	0.0	5.7	1.4	5.5	5.1	3.5	27.0
	III	7.5	7.5	8.5	8.5	6.4	7.0	6.6	7.0	0.5	7.5	1.25	8.0	7.0	4.8	35.5
	IV	10.7	10.1	11.7	11.7	8.4	8.4	9.0	9.0	0.1	10.0	2.25	10.0	8.9	6.0	46.0
	V	15.4	16.0	15.0	11.2	11.8	12.0	12.0	12.0		14.0	5.0	14.0	11.5	8.0	58.0
18	I	3.25	3.65	3.25	3.65	3.4	3.0	3.4	3.0	3.5	3.65	3.05	3.1	3.0	2.0	18.1
	II	5.4	5.5	5.9	5.9	4.8	4.9	4.9	4.9	5.4	5.4	5.2	4.8	5.0	3.4	26.0
	III	7.5	7.5	8.0	8.0	6.5	6.5	6.0	6.0	7.8	7.0	7.0	7.0	6.6	4.5	35.0
	IV	10.9	10.9	10.8	10.8	8.0	8.0	8.5	8.5	9.8	9.8	9.4	9.4	9.0	5.8	45.0
	V	0.0	14.9	0.0	14.0	10.8	10.8	10.8	10.8	13.0	13.0	12.0	12.0	12.0	7.5	57.0
19	I	3.5	3.5	4.0	4.0	3.0	3.0	3.15	2.9	3.8	4.0	3.5	3.4	3.3	2.25	19.8
	II	5.4	5.4	6.0	6.0	5.0	5.0	4.8	5.0	6.0	5.8	5.2	5.0	5.5	3.5	27.5
	III	7.5	7.5	8.0	8.0	6.8	6.5	6.7	6.2	7.9	7.9	7.0	7.0	7.0	4.3	36.5
	IV	10.2	10.0	11.2	10.5	8.2	8.2	8.0	8.0	9.6	9.8	9.0	8.9	9.0	5.6	46.7
	V	13.5	13.0	14.0	13.0	11.0	11.0	10.2	10.2	12.2	12.2	11.4	11.4	12.2	7.2	60.0
	VI	17.0	17.0	17.0	17.0	13.6	13.6	13.4	13.4	16.0	16.0	14.8	14.8	15.5	10.2	78.0
22	I*	3.2	3.75	3.2	3.75	2.9	3.0	3.0	3.0	0.0	3.5	0.0	3.35	3.15	1.9	17.9
	II	5.1	5.1	5.9	5.9	4.5	4.5	4.6	4.6	0.25	5.1	0.25	5.0	5.2	3.1	25.0
	III	7.0	7.0	7.9	8.0	6.0	6.0	6.0	6.0	1.0	7.0	1.0	6.6	7.0	4.0	32.0
	IV	9.4	9.3	9.9	9.9	7.9	7.8	7.5	7.5	2.9	9.0	3.4	8.0	8.0	5.0	42.0
	V	12.4	12.4	13.5	13.5	10.0	10.0	10.0	10.0	7.0	11.6	7.6	10.9	10.8	7.0	56.0
	VI	16.0	16.0	17.0	17.0	13.3	13.3	13.0	13.0	11.5	15.0	11.2	14.0	14.0	9.5	71.0
	VII	22.2	22.2	21.2	21.2	16.4	15.6	16.0	16.0	15.9	19.0	15.3	17.1	18.0	11.7	84.2

23	I	3.25	1.5	3.9	3.9	2.85	3.0	3.0	3.0	3.65	3.7	3.25	3.4	3.0	2.0	18.4
	II	5.0	1.9	6.0	5.5	4.5	4.5	5.0	5.0	6.0	6.0	5.1	5.1	5.0	3.2	24.5
	III	7.0	3.1	8.5	7.9	6.2	6.2	6.2	6.2	7.8	7.8	7.0	7.2	6.2	4.0	32.0
24	IV															
	V	14.5	11.5	14.5	14.0	11.6	11.0	11.0	11.0	13.5	13.5	12.6	12.6	10.1	7.0	50.0
	VI	22.4	17.5	20.5	18.5	16.0	16.0	14.0	14.0	20.5	20.5	17.5	17.5	12.0	8.2	56.0
25	I	3.15	3.25	3.6	3.65	2.75	1.6	3.0	2.75	3.5	3.5	3.2	3.0	3.0	1.9	18.2
	II	5.0	5.0	5.3	5.3	4.3	2.0	4.0	4.0	5.5	5.0	4.9	4.9	4.9	3.0	24.9
	III	6.8	6.8	7.5	7.5	5.8	2.5	5.8	5.4	6.9	6.9	6.3	6.3	6.0	4.0	34.0
	IV	8.0	8.0	9.8	9.8	7.5	3.2	7.5	7.0	8.4	8.4	8.4	8.4	7.8	5.5	44.0
	V	11.5	11.5	12.4	12.4	9.0	6.5	9.0	8.9	11.0	11.0	10.8	10.8	10.1	7.0	55.0
	VI	15.0	15.0	15.5	15.5	11.8	8.5	12.0	11.0	14.0	14.0	13.5	13.5	14.0	9.4	72.0
27	II	5.0	5.1	5.5	5.3	5.0	4.5	4.2	4.5	5.4	0.0	4.9	0.0	4.9	3.0	25.0
	III	7.0	7.0	7.5	7.5	6.0	6.0	5.2	5.8	7.0	1.15	6.9	1.0	6.4	4.1	33.0
	IV	9.0	9.5	9.6	9.6	7.2	7.2	6.9	7.6	8.6	3.8	8.3	4.0	8.0	5.0	42.0
	V	12.0	12.0	13.0	13.0	9.5	9.5	9.0	9.0	11.5	7.5	11.0	7.5	10.5	7.1	55.0
	VI	16.2	16.2	17.0	17.2	12.5	12.5	13.0	13.0	15.0	11.5	14.0	11.5	13.5	9.2	72.0
	VII	20.0	20.0	20.0	20.0	15.0	15.0	15.0	15.0	18.0	15.0	17.9	15.9	15.9	11.4	81.5
	I	3.25	3.25	3.6	3.6	2.8	3.0	2.95	2.8	3.6	3.65	3.2	3.2	3.2	2.0	18.3
27	II	5.4	5.4	5.6	5.6	4.5	4.2	4.6	4.3	5.7	5.6	5.0	5.0	5.0	3.0	26.0
	III	7.2	7.2	8.0	8.0	6.0	5.8	5.8	6.0	7.2	7.2	6.2	6.2	6.8	4.0	34.0
	IV	9.5	9.5	10.0	10.0	7.6	7.0	7.8	7.8	8.9	8.9	8.5	8.5	8.2	5.2	42.0
	V	14.0	14.0	14.0	14.0	11.0	11.0	10.4	10.4	12.6	12.6	12.0	12.0	11.5	7.5	57.5
	VI	23.0	23.0	22.0	22.0		17.5		14.5	20.0	20.0	17.5	17.5	14.5	9.5	75.0

30	I	3.0	3.25	3.7	3.5	2.9	0.0	3.0	0.0	0.0	3.75	0.0	3.1	3.1	2.0	18.5
	II	5.0	5.0	5.6	5.5	4.5	0.5	4.4	0.5	0.5	5.1	0.5	4.5	5.0	3.0	26.0
	III	7.0	7.0	7.5	7.5	5.6	1.75	6.0	1.75	1.75	6.9	1.75	6.3	6.2	4.5	33.0
IV																
31	V	11.2	11.2	12.1	12.1	9.0	8.0	9.0	9.0	8.0	11.0	8.9	10.0	10.1	7.0	54.0
	VI	14.0	14.0	15.5	15.5	11.0	10.5	11.8	12.5	11.9	13.0	12.0	13.0	13.9	9.0	69.0
	III	8.2	0.8	9.2	0.8	7.0	7.0	7.2	7.2	8.0	8.0	8.0	8.0			40.0
32	IV	11.0	2.4	12.0	2.9	9.5	9.5	9.9	9.9	11.5	11.5	10.6	10.6			
	V	15.5	9.5	16.2	10.0	12.0	12.0	13.8	13.8	15.0	15.0	15.0	15.0	14.0	9.0	
	VI															
33	VII	24.5	18.0	24.0	18.4	18.0	18.0	17.2	17.2	23.0	23.0	22.0	22.0	17.0	12.0	75.0
	II	5.0	5.0	5.5	5.5	4.6	0.0	4.3	0.0	5.5	5.5	4.5	4.5	4.9	3.0	25.0
	III	7.0	7.0	7.6	7.6	6.0	6.6	6.3	0.6	8.0	8.0	7.0	7.0	6.8	4.2	34.0
34	IV	9.4	9.4	10.0	10.0	8.0	2.0	8.0	2.2	9.9	9.0	9.0	9.0	8.4	4.9	44.0
	V															
	VI	20.6	20.6	18.5	18.5	15.0	13.0	15.8	13.2	20.0			17.8	14.0	10.0	65.5
35	III	7.5	7.5	8.7	8.7	6.4	6.3	6.2	6.2	0.6	8.0	0.6	7.0	7.0	4.0	35.0
	IV	10.6	10.6	11.9	11.9	8.0	8.0	8.4	8.4	2.0	9.9	2.0	9.4	9.0	5.9	48.0
	V	13.4	13.4	14.2	14.2	10.0	10.0	10.5	10.5	7.0	12.1	7.0	11.3	11.5	7.5	62.5
36	VI	18.0	18.0	18.6	18.6	13.5	13.5	13.8	13.8	12.0	16.0	11.5	15.0	14.5	10.0	76.5
	VII	23.0	23.0	22.5	22.5	16.0	16.0	16.0	16.0	16.6	20.0	16.0	18.5	18.0	11.6	85.0

34	II	5.0	0.0	5.8	0.0	0.0	4.5	0.0	4.4	5.1	5.1	5.0	5.0	3.0	25.0
	III	7.8	0.75	8.5	0.75	0.6	6.2	0.6	0.6	7.0	7.0	7.0	7.0	5.0	35.0
	IV	10.4	2.0	11.0	2.4	2.0	8.1	1.8	8.0	9.5	9.5	9.5	8.9	5.8	44.5
	V	13.7	8.4	14.4	9.0	0.0	10.5	1.6	10.7	12.5	12.5	12.0	12.0	8.1	57.0
	VI	20.0	16.5	19.5	16.2		15.2	2.8	15.0	18.4	18.4	17.5	17.5	10.0	67.0
	II	5.0	5.0	5.8	5.8	4.5	0.0	4.5	0.0	0.0	5.9	0.0	5.2	3.0	26.5
35	III	7.9	7.9	8.0	8.0	6.5	0.75	6.5	0.75	0.6	8.0	0.6	7.0	4.5	35.5
	IV	10.5	10.5	11.2	11.2	8.5	2.2	8.2	2.2	2.1	10.1	2.1	9.1	5.9	46.0
	V	12.0	12.0	13.0	13.0	10.0	7.0	10.0	6.6	10.0	12.0	11.0	11.0	7.0	56.4
	VI	15.2	15.2	16.2	16.2	12.0	9.0	12.0	10.0	12.0	15.0	13.0	14.0	8.5	66.0
	II	4.5	4.5	5.0	5.0	0.0	0.0	0.0	0.0	5.2	5.2	4.3	4.3	3.0	24.0
	III	6.2	6.2	8.0	8.0	0.75	0.75	0.75	0.75	6.8	6.8	6.1	6.1	4.0	33.0
36	IV	0.0	9.0	0.0	9.8	2.4	2.4	2.5	2.5	1.2	8.2	8.0	8.0	5.0	43.0
	V	2.5	11.6	2.5	12.2	6.2	6.2	6.6	6.6	0.8	10.5	10.0	10.5	7.0	54.5
	VI	9.2	16.6	9.2	16.0	10.0	10.0	10.0	10.0	1.8	13.5	11.5	13.4	9.5	72.0
	VII	20.0	17.5	19.5	19.5	14.0	14.0	14.3	14.3	4.0	17.0	15.0	16.7	11.4	81.0
	II									0.25	0.25	0.25	0.25		
	III	7.2	7.2	8.0	8.0	6.0	6.0	6.5	6.5	0.75	0.75	0.75	0.75	4.5	35.5
37	IV	10.0	10.0	10.5	10.5	8.0	8.0	8.2	8.2	2.0	2.0	2.0	2.0	5.0	45.6
	V	12.0	12.0	13.2	13.2	10.0	10.0	10.0	10.0	7.4	7.4	6.5	6.5	7.0	58.0
	VI	16.2	16.2	15.8	15.8	12.3	12.3	12.8	12.8	11.0	11.0	10.9	10.9	9.5	73.5
	VII	21.0	21.0	20.3	20.3	15.0	15.0	15.2	15.2	16.0	15.5	14.9	14.7	11.2	87.0
	II														
	III	7.2	7.2	8.0	8.0	6.0	6.0	6.5	6.5	0.75	0.75	0.75	0.75	4.5	35.5

42	I	3.25	3.25	3.65	3.65	3.0	3.0	3.0	3.0	3.5	0.0	3.25	0.0	3.3	2.0	19.0
	II	5.0	5.0	6.0	6.0	4.8	4.8	4.8	4.6	5.6	0.6	5.0	0.6	5.0	3.2	25.5
43	I	3.1	3.1	3.6	3.25	0.0	0.0	0.0	0.0	3.6	3.6	3.1	3.1	3.0	1.9	17.8
	II	5.0	5.0	5.2	5.2	0.5	0.5	0.5	0.5	5.0	0.35	4.8	0.35	4.9	3.0	24.5
44	I	3.2	3.25	3.8	3.6	2.8	2.7	2.7	2.8	0.0	0.0	0.0	0.0	3.0	2.0	18.5
	II	5.0	5.0	5.6	5.6	4.2	4.2	4.3	4.3	0.4	0.4	0.4	0.4	4.8	3.0	25.0
	III	7.0	7.0	8.0	8.0	6.0	6.0	6.1	6.1	1.0	1.0	1.0	1.0	6.4	4.0	35.0
	IV															
45	V	12.9	12.9	13.6	13.6	9.9	9.9	10.0	10.0	7.0	3.9	7.8	3.9	10.1	7.5	57.0
	VI	16.6	16.6	17.0	17.0	12.3	12.3	12.0	12.0	13.0	6.0	12.0	7.0	13.0	9.8	70.0
	I	3.5	3.5	3.75	3.75	0.0	3.0	0.0	3.0	4.0	0.0	3.4	0.0	3.05	2.0	18.1
	II	5.2	5.2	6.0	6.0	0.35	4.8	0.35	4.8	6.0	0.35	5.0	0.35	5.1	3.7	27.0
46	III	7.9	7.9	8.0	8.0	1.35	6.7	1.25	6.0	7.5	1.25	7.0	1.35	6.6	4.0	37.0
	IV															
	V	14.0	14.0	15.0	15.0	9.9	10.8	8.9	10.8	13.0	10.7	12.2	9.7	12.0	7.8	58.0
	VI	22.0	22.0	20.2	20.2	16.0	16.0	14.6	14.6	19.5	19.0	18.0	16.8	14.2	9.2	66.0
46	I	3.4	3.25	3.75	3.7	3.0	3.0	3.15	3.0	3.65	3.6	3.35	3.35	2.8	1.75	19.0
	II	5.0	5.0	5.8	5.8	4.5	4.5	4.5	4.5	5.8	5.5	5.0	5.0	4.2	3.0	25.0
	III	7.0	7.0	7.9	7.9	5.9	5.9	6.0	6.0	7.3	7.3	6.5	6.5	6.2	4.0	34.0
	IV															
46	V	12.5	12.5	13.5	13.5	9.6	9.6	10.0	10.0	11.5	0.0	11.5	0.0	10.8	7.0	53.0
	VI	16.0	16.0	17.1	17.1	11.0	11.0	13.0	13.0	14.5	2.0	14.2	2.1	13.9	9.0	67.0

47	I	3.1	3.2	3.5	3.5	0.0	3.0	0.0	2.7	3.75	3.75	3.2	3.2	3.0	1.75	18.5
	II	4.9	4.9	5.9	5.9	0.5	4.1	0.5	4.5	5.6	5.3	5.0	5.0	5.0	3.2	26.0
	III	7.0	7.0	7.4	7.4	1.0	6.2	0.9	6.0	7.0	7.0	6.5	6.5	6.0	4.0	34.0
	IV	9.4	9.4	10.0	10.0	2.8	7.8	3.2	7.8	9.1	9.1	8.5	8.5	8.1	5.8	44.0
48	V															
	VI	15.0	15.0	16.7	16.7	9.4	12.0	10.0	12.5	14.5		14.0	14.0	13.1	9.1	70.0
	VII	20.1	20.1	20.1	20.1	12.7	14.8	13.2	15.3	18.0		17.0		16.0	10.9	81.0
	IV															
49	I	3.15	3.15	3.5	3.5	3.0	3.0	2.7	2.7	0.0	3.75	0.0	3.15	3.1	2.0	18.0
	II	5.0	5.0	5.8	5.8	4.6	4.1	4.5	4.1	0.5	5.6	0.5	5.0	5.0	3.0	25.5
	III	7.2	7.2	7.9	7.9	6.2	6.2	6.0	6.0	0.9	7.2	0.9	6.5	6.3	3.9	35.0
	IV															
50	V	13.0	13.0	13.8	13.8	10.0	10.0	10.0	10.0	2.0	12.0	5.6	11.2	11.0	7.8	58.0
	VI	17.0	17.0	17.2	17.2	12.4	12.4	13.1	13.1	4.0	15.2	9.0	14.5	14.0	9.8	70.0
	I	0.0	3.25	0.0	3.2	2.9	2.9	2.7	2.7	3.5	3.5	3.0	3.0	2.7	1.6	16.5
	II	0.35	0.0	0.35	0.0	4.2	4.1	4.1	4.1	5.0	5.0	4.9	4.8	5.0	3.0	24.0
51	III	0.65	0.35	0.65	0.35	5.8	5.8	5.7	5.7	7.0	7.0	6.3	6.3	6.0	4.0	33.0
	IV	3.9	0.0	3.2	1.9	7.4	7.4	7.3	7.3	9.1	9.1	8.2	8.2	8.0	5.0	40.8
	V	8.0	0.0	7.8	2.8	9.9	9.9	10.9	10.9	12.1	12.1	11.1	11.1	10.5	6.8	53.0
	I	3.5	3.5	3.75	3.6	3.0	3.0	3.0	3.0	3.75	3.75	3.5	3.5			17.5
52	II	5.0	5.0	5.9	5.9	4.5	4.5	4.5	4.5	5.0	5.7	5.0	5.0	4.8	3.0	24.0
	III	7.0	7.0	7.6	7.6	6.0	6.0	5.8	5.8	7.0	7.0	6.5	6.5	6.4	4.0	32.5
	VI	9.0	9.0	10.0	10.0	7.8	7.8	7.5	7.5	9.5	9.5	8.5	8.5	8.0	5.2	44.0
	V	12.0	11.1	9.4	9.4	9.6	9.6	9.3	9.3	11.6	11.6	10.8	10.8	10.5	7.4	55.0

I	3.25	3.15	3.6	3.5	2.9	3.0	3.1	3.1	3.5	3.5	3.1	3.1	3.1	2.0	18.2
II	5.0	5.0	4.3	4.3	0.0	4.8	0.0	4.8	5.0	5.4	4.8	4.8	5.0	3.0	25.6
III	7.0	7.0	7.5	7.5	0.4	6.1	0.4	6.0	6.8	7.3	6.2	6.2	6.5	4.0	35.0
IV	9.0	9.0	9.8	9.8	1.8	7.5	1.8	7.5	8.1	9.0	8.0	8.0			45.4
V															
VI	16.0	16.0	16.0	16.0	10.9	11.1	10.0	11.9	13.0	13.9	12.8	12.8	12.9	9.0	68.0
I	3.3	3.3	3.7	3.5	3.0	3.0	3.0	3.0	3.6	3.6	3.25	3.25	2.85	1.8	16.0
II	5.1	5.1	5.1	5.1	4.2	4.3	4.2	4.3	0.4	5.0	0.4	4.2	4.5	2.5	23.0
III															
IV	9.1	9.1	9.8	9.8	7.3	7.3	7.0	7.0	4.0	4.5	4.0	7.7	7.9	5.0	39.2
V	13.2	13.2	13.7	13.0	10.5	10.5	9.6	9.6	9.1	7.0	8.0	10.0	10.2	7.0	50.0
II	5.1	5.1	6.0	6.0	4.8	0.0	4.5	2.0	6.0	6.0	5.0	5.0	4.9	3.2	
III	7.5	7.4	8.4	8.4	7.0	0.35	6.1	1.75	8.0	8.0	7.1	7.0	6.8	4.2	
IV	10.0	10.0	10.5	10.5	7.6	0.5	7.7	1.2	10.2	10.2	9.2	9.2	8.8	6.0	
V	14.5	14.5	15.0	14.6	10.9		11.0	1.5	13.5	13.5	12.8	12.8	11.7		
VI	22.6	22.6	20.0	20.0	16.2		15.2		21.6	21.6	18.0	18.0	14.0	9.2	
II	4.3	4.5	5.5	5.3	4.3	4.0	4.0	4.0	0.0	5.0	0.0	4.9	4.4	2.7	14.2
III	6.5	7.0	7.0	7.0	5.5	5.8	5.6	5.8	0.75	7.4	0.75	7.0	5.2	3.8	32.0
IV	8.5	8.5	9.8	9.8	7.0	7.0	7.0	7.0	2.2	9.0	2.3	8.6	7.5	4.5	42.0
V	11.5	11.5	13.0	13.0	9.0	9.0	9.5	9.5	7.6	11.6	7.5	10.8	10.0	6.8	54.0
VI	15.0	15.0	16.0	16.0	11.8	11.8	17.0	17.0	12.4	14.5	12.5	14.0	13.0	9.0	68.0
VII	19.2	19.2	19.8	20.5	15.1	14.6	14.9	14.9	16.5	17.8	16.5	19.0	16.0	10.5	82.0

57	II	0.0	5.0	3.2	5.4	4.5	4.2	4.4	4.5	5.1	5.4	5.0	4.9	5.0	3.0	26.0
	III	0.0	7.1	2.4	8.0	6.0	6.0	6.1	6.1	7.5	7.5	7.0	7.0	7.0	4.2	35.0
	IV	0.4	10.0	3.0	10.7	8.0	8.0	9.0	9.0	9.2	9.2	9.2	9.2	8.9	5.5	46.5
	V	1.25	12.9	3.0	14.8	10.0	10.0	10.6	10.6	12.1	12.1	12.0	12.0	12.0		62.0
	VI	2.0	17.0	3.2	17.8	12.9	12.9	13.0	13.0	15.0	15.0	15.0	15.0	15.0	10.1	76.0
	II	5.1	0.0	5.8	5.8	4.5		4.1	4.1	5.5	5.5	5.0	5.0	4.9	3.0	25.5
58	III	7.6	0.36	8.2	8.0	6.2	6.0	6.0	6.0	7.5	8.0	7.0	7.0	6.4	4.2	34.0
	IV	9.8	1.5	10.4	9.2	7.6	7.6	8.0	8.1	8.5	10.0	8.9	8.9	7.8	5.4	44.0
	V	13.6	6.0	14.4	13.0	10.2	10.2	10.9	10.9	12.0	14.0	12.5	13.9	10.5	6.5	53.0
	VI	21.2	16.5	20.2	19.0	16.0	17.5	15.6	15.6	18.8	18.8	18.0	19.2	12.0	8.0	56.0
	II	5.0	5.0	5.5	5.5	4.4	0.0	4.4	4.4	5.4	5.0	4.4	5.0	5.0	3.0	16.8
	III	7.0	7.0	8.0	8.0	6.5	0.35	6.2	5.5	7.0	7.0	6.7	6.7	7.2	4.5	36.0
59	IV	10.0	10.0	10.2	10.2	7.4	0.6	8.0	7.0	9.2	9.2	9.0	9.0	9.4	5.9	47.0
	V	13.2	13.2	13.7	13.7	10.1	4.0	10.6	8.6	12.0	12.0	11.2	11.2	12.5	8.2	60.0
	VI	22.1	22.1	20.9	20.9	15.0	12.0	15.5	15.0	18.6	18.6	18.6	18.6	14.6	9.6	65.6
	III	7.9	7.6	8.0	8.1	6.6	6.6	6.6	6.6	7.8	0.5	7.0	0.5	6.7	4.5	33.0
	IV	10.0	10.0	11.0	11.0	8.4	8.0	8.2	7.5	10.0	2.0	9.4	2.0	9.0	6.0	44.5
	II	5.0	5.0	5.5	5.5	4.5	2.0	4.2	4.0	5.0	5.0	4.9	4.9			15.5
60	III	7.9	7.9	8.1	8.1	6.0	3.0	6.0	6.0	6.3	7.0	7.0	6.8	7.0	4.2	35.0
	IV	10.2	10.2	10.5	10.5	8.5	3.5	8.0	7.9	10.0	9.8	9.3	9.2	8.5	5.6	44.0
	V	14.9	14.9	15.0	15.0	10.5	5.6	10.9	10.1	13.3	13.3	12.9	12.9	12.0	7.8	56.0
	VI	20.0	20.0	18.6	18.6	14.2	7.5	15.0	12.0	18.2	17.2	17.2	17.2	15.0	10.0	71.0
	II	5.0	5.0	5.5	5.5	4.5	2.0	4.2	4.0	5.0	5.0	4.9	4.9			15.5
	III	7.9	7.9	8.1	8.1	6.0	3.0	6.0	6.0	6.3	7.0	7.0	6.8	7.0	4.2	35.0
62	IV	10.2	10.2	10.5	10.5	8.5	3.5	8.0	7.9	10.0	9.8	9.3	9.2	8.5	5.6	44.0
	V	14.9	14.9	15.0	15.0	10.5	5.6	10.9	10.1	13.3	13.3	12.9	12.9	12.0	7.8	56.0
	VI	20.0	20.0	18.6	18.6	14.2	7.5	15.0	12.0	18.2	17.2	17.2	17.2	15.0	10.0	71.0
	II	5.0	5.0	5.5	5.5	4.5	2.0	4.2	4.0	5.0	5.0	4.9	4.9			15.5
	III	7.9	7.9	8.1	8.1	6.0	3.0	6.0	6.0	6.3	7.0	7.0	6.8	7.0	4.2	35.0
	IV	10.2	10.2	10.5	10.5	8.5	3.5	8.0	7.9	10.0	9.8	9.3	9.2	8.5	5.6	44.0

63	II	5.0	5.0	6.0	6.0	4.9	4.5	4.6	4.2	5.2	0.0	4.8	0.0	4.9	3.0	26.0
	III	7.0	7.0	7.8	7.6	6.0	6.0	6.0	6.0	7.0	0.5	7.0	0.5	7.0	4.6	34.5
	IV	9.9	9.5	10.4	10.0	7.5	7.5	8.0	8.0	9.4	2.1	8.6	2.0	9.0	5.7	44.0
	V	12.0	11.0	12.8	12.5	9.9	9.9	9.4	9.4	11.5	7.2	10.9	7.6	10.8	7.0	56.0
	VI	15.0	14.0	16.5	15.3	11.0	11.0	11.8	11.5	14.4	12.1	13.6	11.6	13.0	9.0	69.5
	II	4.5	4.5	5.0	5.0	4.0	4.0	4.2	4.2	5.0	5.0	4.6	4.6	4.6		25.0
64	III	7.0	7.0	7.2	7.2	5.2	6.0	6.0	6.0	7.8	7.8	7.0	6.3	6.2	4.0	32.0
	IV	9.0	9.0	9.8	9.8	6.8	7.2	7.0	7.0	9.1	9.1	8.5	8.5	8.0	4.9	42.0
	V	13.6	13.6	13.9	13.9	11.1	10.4	10.0	10.0	12.6	13.2	12.0	12.0	10.8	7.0	53.5
	VI	21.0	21.0	20.0	20.0	18.0	15.0	15.0	15.0	19.5	20.0	17.5	17.5	13.6	8.3	63.5
	II	5.0	5.0	5.5	5.5	4.5	4.5	4.2	4.5	5.8	5.4	4.9	5.0	5.0	3.0	16.5
	III	7.2	7.2	8.0	8.0	6.0	6.5	6.0	6.0	8.0	7.8	7.0	7.0	6.5	4.5	36.0
65	IV	10.2	10.2	10.9	10.9	8.0	8.0	8.0	8.0	10.0	9.5	8.9	8.9	9.0	5.6	45.0
	V	15.0	15.0	15.0	15.0	10.9	10.9	11.2	11.2	14.0	13.5	12.0	12.0	11.5	7.4	58.0
	VI	22.2	22.2	21.0	21.0	16.0	16.0	16.5	16.5	21.8	21.8	18.0	18.0	14.8	9.2	65.8
	III	7.0	7.0	7.6	7.8	6.3	6.1	6.2	6.0	0.0	0.0	0.0	0.0	7.0	4.6	35.7
	IV									0.75	0.75	0.75	0.75	9.0		
	V	0.85	11.1	1.0	12.6	9.2	9.2	9.0	9.0	2.5	2.5	2.9	2.9	11.0	7.5	59.0
54b	VI	4.6	15.1	4.6	16.9	11.4	11.4	12.0	12.0	8.8	6.2	8.8	8.8	14.9	10.1	77.5
	VII	12.0	20.5	12.5	21.3	15.0	15.0	15.6	15.6	15.1	13.0	13.9	13.9	18.2	12.8	88.0
	III	7.0	7.0	7.6	7.6	6.0	6.0	6.0	6.0	0.0	7.0	0.0	6.5	6.9	4.2	34.0
	IV									2.0		2.0		8.9		
	V	12.8	12.8	13.0	13.0	7.6	9.2	9.0	10.0	7.0	11.0	6.2	10.5	11.4	7.2	54.2
	VI	15.1	15.0	16.0	15.2	11.8	11.8	11.9	11.9	11.0	13.6	10.5	13.5	14.0	8.4	64.5

	II	4.2	4.6	5.2	5.2	5.2	3.8	4.1	4.5	4.1	5.0	0.0	4.1	2.3	4.5	3.0	23.0
	III	6.3	7.0	7.0	7.4	7.4	5.5	5.5	5.6	5.6	6.2	0.0	6.0	1.6	6.0	3.8	33.0
	IV	9.0	9.0	9.9	9.9	9.9	7.5	7.5	7.2	7.2	8.1		8.1	1.9	6.0	3.8	42.0
71	V	13.0	13.0	13.9	13.9	13.9	9.9	9.9	10.9	10.9	11.5		11.6		8.0	5.4	55.0
	VI														11.0	7.5	
	II	4.9	4.9	5.5	5.5	5.5	4.1	4.1	4.2	4.2	5.2	0.0	5.0	4.8	4.9	2.9	25.0
	III	7.0	7.0	7.8	7.8	7.8	6.0	6.0	6.0	6.0	7.2	0.0	6.6	5.9	6.0	4.0	33.0
72	IV	5.5	9.6	10.2	10.2	10.2	7.6	7.6	7.9	7.9	9.1	0.0	8.7	7.2	8.5	5.4	43.0
	V	7.5	14.5	14.0	14.0	14.0	11.0	11.0	11.6	11.6	12.9		12.0	9.0	11.0	7.8	54.0
	II	4.8	4.8	5.0	5.0	5.0	3.8	3.8	4.0	4.0	4.9	2.0	4.5	4.0	4.9	2.9	24.0
	III	6.0	6.0	7.0	7.0	7.0	5.4	5.4	5.4	5.4	6.2	2.4	5.9	5.4	5.9	3.5	32.0
73	IV																
	V	11.0	11.0	12.0	12.0	12.0	9.0	9.0	9.0	9.0	10.0	3.0	9.5	9.0	10.0	6.5	51.0
	VI	15.0	15.0	15.9	15.9	15.9	11.8	11.8	11.8	11.8	13.0	4.0	12.8	12.0	14.0	8.5	72.0
	II	5.0	0.0	5.4	0.0	0.0	0.0	4.3	1.7	4.3	5.5	5.5	4.8	4.8	4.9	3.0	25.0
	III	7.2	0.25	7.2	0.25	0.25	0.0	6.0	2.0	5.9	7.2	7.2	6.5	6.5	6.2	4.0	33.0
74	IV	9.6	2.1	10.2	2.6	2.6	8.0	8.0	1.8	7.4	9.4	9.4	9.0	9.0	8.0	5.0	43.2
	V	14.6	9.1	14.5	9.0	9.0	11.0	11.0	1.8	10.7	13.5	13.5	12.0	12.0	11.0	7.5	55.5
	IV	8.3	8.3	9.5	9.5	9.5	6.9	6.9	7.0	7.0	8.0	8.2	8.0	8.0	*	7.8	42.0
84	V	11.0	11.0	12.0	12.0	12.0	8.6	8.6	9.2	9.2	9.6	10.6	10.0	10.3	10.0	6.9	52.8
	VI	14.5	14.5	15.2	15.2	15.2	11.0	11.0	11.5	11.5	12.0	13.0	12.0	13.0	12.0	9.0	66.0
	VII	19.0	19.0	19.0	19.0	19.0	13.6	13.6	14.0	14.0	16.1	16.8	15.8	16.1	15.8	10.0	78.0

85	IV	9.0	8.5	9.5	9.2	7.0	7.0	7.5	8.5	8.5	8.0	7.8	7.7	5.0	40.0
	V	12.8	11.5	13.2	12.8	9.2	9.2	10.0	11.0	11.0	11.2	11.2	10.6	7.0	53.0
	VI	15.0	15.0	15.6	15.6	11.2	11.2	12.0	14.0	14.0	14.0	14.0	13.5	9.0	68.5
	VII	21.2	21.6	20.6	20.4	15.2	15.2	16.0	17.7	17.7	18.6	18.6	17.0	11.0	83.0
86	IV	5.0	10.2	10.8	10.8	8.5	8.0	8.4	10.0	10.0	9.2	9.2	9.0		47.0
	V	8.5	14.5	14.5	14.3	11.1	11.1	11.0	13.0	13.0	13.0	13.0	12.6	8.7	59.2
	VI	17.0	23.0	21.0	21.0	16.0	16.0	16.5	21.0	21.0	19.6	19.6	16.0	11.0	73.0
87	IV	9.9	9.9	9.9	9.9	3.6	7.1	7.2	7.1	9.2	9.6	8.1	8.0	6.8	43.0
	V	12.0	12.0	13.0	13.0	4.5	4.5	8.5	9.0	9.8	11.2	10.6	10.6	7.1	57.5
	VI	16.7	16.7	17.0	17.0	7.2	11.0	13.0	13.0	15.0	15.0	14.0	14.0	10.0	73.0
	VII	21.8	21.8	21.0	21.0	10.2	14.4	15.4	15.0	19.5	17.5	17.5	18.5	12.0	88.0
63	II	5.0	5.0	4.9	4.9	0.0	0.0	0.0	5.0	5.0	4.5	4.5	4.5	2.8	24.0
	III	6.0	6.0	7.0	7.0	0.35	0.35	0.5	7.0	7.0	6.0	6.0	5.8	3.7	32.0
64	II	4.6	4.6	5.1	5.1	4.0	4.0	4.0	5.1	5.1	4.9	4.9	4.8	2.9	24.0
	III	6.9	6.9	7.5	7.5		6.0	5.7	5.5	7.0	6.4	6.4	6.0	3.9	33.0
	IV	9.0	9.0	9.9	9.9	0.0	7.6	0.0	7.5	9.3	8.2	8.2	8.0	5.1	43.0
	V	12.9	12.9	14.0	14.0	2.0	10.0	2.0	10.0	11.5	11.5	11.6	11.5	7.0	56.0
65b	II	4.5	4.5	5.0	5.0	0.0	4.2	0.0	4.0	5.0	4.2	4.2	4.2	2.7	24.0
	III	6.6	6.6	7.2	7.2	0.25	5.6	0.35	5.5	6.6	6.0	6.0	5.9	3.8	32.0
	IV	9.0	9.0	9.5	9.5	2.0	7.4	2.0	7.0	9.0	8.0	8.0	7.5	5.1	41.0
	V	12.0	12.0	12.6	12.6	7.0	9.9	7.0	9.1	11.1	10.2	10.2	9.8	7.0	53.0

66	II	5.0	0.0	5.5	0.0	4.0	4.0	4.0	4.0	4.0	5.4	5.0	4.9	4.5	4.8	2.9	25.0
	III	7.0	0.3	7.5	0.25	0.35	6.0	0.35	5.6	7.0	7.0	7.0	6.2	6.0	6.0	3.7	32.0
	IV	10.0	2.0	10.5	2.2	2.0	7.8	1.9	7.5	6.2	8.5	8.5	9.0	9.0	8.5	5.6	43.2
	V	14.5	7.8	14.4	9.0	6.0	10.5	7.5	10.1	7.6	12.9	11.8	11.8	11.8	11.0	7.4	56.0
75	II	4.9	4.9	5.2	5.2	4.2	2.9	4.0	4.0	5.3	5.0	4.5	4.5	4.7	4.5	3.0	25.0
	III	7.0	7.0	7.5	7.5	5.9	3.0	6.0	5.5	6.9	6.4	6.4	6.4	6.4	6.4		33.9
	IV	9.7	9.7	10.0	10.0	7.9	4.2	7.0	7.0	9.0	9.0	8.8	8.8	8.8	8.0	5.1	43.0
	V	13.6	13.6	14.2	14.2	10.9	6.8	11.0	9.4	12.0	12.0	12.0	12.0	12.0	11.4	8.0	57.5
76	II	5.0	2.4	5.2	5.2	4.0	4.0	4.0	4.0	5.4	5.4	5.4	4.5	4.5	4.9	3.0	25.0
	III	6.5	2.5	7.0	7.0	5.5	5.5	5.2	5.2	6.9	6.9	6.9	6.1	6.1	7.0		33.0
	IV	11.3	6.2	11.6	11.6	8.6	8.6	8.6	8.6	11.0	11.0	11.0	10.0	10.0	10.5	6.9	40.0
	V	14.1	10.0	15.0	14.0	10.9	10.9	11.0	11.0	13.1	13.1	13.1	13.0	13.0	12.8	9.0	65.0
88	IV	0.0	9.5	0.0	10.4	7.4	7.4	8.0	8.0	9.2	9.2	8.6	8.6	8.6	9.5	6.0	46.0
	V	0.0	12.5	0.75	13.5	10.0	10.0	10.0	10.0	12.1	12.1	11.6	11.6	11.6	12.0	7.5	58.0
	VI		16.5	2.8	16.8	12.5	12.5	13.0	13.0	14.2	14.2	14.2	14.2	14.2	14.5	9.6	74.0
90	IV	10.0	10.0	10.6	10.6	7.9	7.9	8.0	8.0	0.0	0.0	0.0	0.0	0.0	9.0	5.5	45.0
	V	14.0	14.0	12.0	12.0	14.0	14.0	9.6	9.6	0.5	0.5	0.5	0.5	0.5	11.0	7.0	56.0
	VI	16.0	16.0	17.0	17.0	12.0	12.0	13.0	13.0	3.0	3.0	3.1	3.1	3.1	13.3	9.1	69.0
91	IV	9.6	0.0	10.4	0.0	7.6	7.6	8.0	8.0	0.0	9.1	0.0	0.0	9.0	9.0	5.6	47.5
	V	13.0	0.25	13.5	0.25	10.0	10.0	10.0	10.0	0.25	12.0	0.25	11.7	11.7	12.0	7.0	61.0
	VI	16.0	3.0	17.0	5.0	12.0	12.0	12.0	12.0	2.0	14.9	4.0	13.8	14.0	14.0	9.5	73.0

92	IV	10.0	10.0	10.2	10.2	7.9	7.9	8.0	8.0	0.0	9.3	0.0	9.0	8.4	5.2	44.5
	V	13.5	13.5	14.0	14.0	10.2	10.2	10.0	10.0	0.8	11.9	1.0	11.8	11.2	7.1	57.0
	VI	17.5	17.5	17.5	17.5	12.2	12.2	13.0	13.0	1.3	15.0	4.0	14.0	14.0	9.8	70.0
93	IV	10.6	10.6	11.2	11.2	0.0	8.5	0.0	8.1	10.6	10.6	9.2	9.2	9.0	5.4	47.0
	V	14.0	14.0	14.9	14.9	0.75	11.0	0.75	11.1	13.2	13.2	12.0	12.0	12.0	8.2	59.0
	VI	18.0	18.0	18.5	18.5	4.0	13.4	4.0	13.8	16.2	16.2	15.0	15.0	14.5	10.0	74.0
94	V	5.5	13.0	13.0	13.0	0.0	10.5	0.0	10.0	12.7	0.0	11.0	0.0	11.0	7.1	57.0
	VI	7.3	16.0	16.5	16.5	2.3	13.0	2.7	13.0	15.0	2.8	14.3	3.0	14.0	9.0	70.0
95	V	12.0	12.0	13.0	13.0	0.0	0.0	0.0	0.0	10.9	10.9	11.0	11.0	11.3	7.1	57.0
	VI	15.3	15.3	16.0	16.0	0.0	2.5	0.0	2.3	14.0	14.0	14.0	14.0	14.2	9.1	68.5
96	IV	10.8	10.8	11.0	11.0	0.0	0.0	0.0	0.0	9.9	9.9	9.2	9.2	9.0	6.1	47.5
	V	15.0	15.0	15.5	15.5	1.0	1.0	1.0	1.0	13.2	13.2	12.5	12.5	12.0	8.1	58.0
	VI	21.4	21.4	21.0	21.0	4.0	4.0	3.8	3.8	18.5	18.5	7.6	7.6	15.0	9.6	67.0
97	IV	10.4	10.4	10.5	10.5	8.5	8.5	8.4	8.4	10.3	0.0	9.2	0.0	9.2	6.0	47.5
	V	15.0	15.0	15.0	15.0	12.0	12.0	10.9	10.9	14.2	1.0	13.0	1.0	12.0	7.0	60.0
	VI	23.0	23.0	20.0	20.0	19.0	19.0	15.0	15.0	21.0	5.0	18.1	2.5	15.0	9.5	65.0
98	IV	9.6	9.6	10.2	10.2	7.5	7.5	8.0	8.0	0.0	9.2	0.0	8.8	9.0	6.0	47.0
	V	12.5	12.5	13.4	13.4	10.0	10.0	10.0	10.0	0.25	11.5	0.20	11.0	12.0	8.0	58.7
	VI	16.0	16.0	17.0	17.0	12.0	12.0	12.7	3.0	14.5	3.0	15.0	15.0	15.0	10.5	72.0
	VII	22.0	22.0	20.8	20.8	14.0	15.5	10.2	19.0	10.4	17.3	17.5	11.0	86.0		

99	IV	9.0	9.0	9.8	9.8	7.0	7.0	7.2	7.5	0.0	9.0	0.0	8.6	8.0	5.0	44.5
	V	12.0	12.0	13.1	13.1	8.9	8.9	9.8	9.8		12.0		10.5	11.0	7.1	58.1
	VI	20.5	20.5	19.5	19.5	15.0	15.0	15.5	15.5	6.2		4.9		14.5	9.8	65.0
100	IV	9.5	9.5	10.2	10.2	7.9	7.9	7.9	7.9	0.0	0.0	0.0	0.0	8.9	5.6	46.0
	V	14.0	14.0	14.0	14.0	11.0	11.0	10.9	10.9	0.1		0.1		11.5	8.0	57.0
	VI	16.8	16.8	16.8	16.8	11.8	11.8	12.1	12.1	3.8		3.8		14.5	9.0	73.0
101	IV	0.0	9.4	0.0	10.4	7.0	7.3	7.6	7.6	9.0	9.0	8.6	8.6	8.0	5.3	45.0
	V	0.75	12.8	0.5	13.0	9.0	9.0	9.5	9.5	11.9	11.9	11.0	11.0	10.9	7.2	55.0
	VI	2.8	16.0	4.0	16.5	12.0	12.0	13.0	13.0	14.5	14.5	13.5	13.5	13.0	9.5	70.0
	VII	10.2	19.6	11.7	20.2	14.0	14.5	14.9	14.9	18.0	18.0	17.0	17.0	16.5	10.6	80.0
102	IV	10.6	0.0	11.5	0.0	8.5	8.5	8.2	8.2	10.5	10.5	9.2	9.2	9.2	6.0	57.8
	V	15.1	1.0	15.5	1.0	11.4	11.4	11.4	11.4	13.8	13.8	13.2	13.2	12.6	8.0	57.0
	VI	23.0	7.0	21.2	6.4	16.1	16.1	16.0	16.0	20.0	20.0	19.0	19.0	15.2	10.0	67.0
103	IV	11.0	11.0	11.1	11.1	9.2	0.0	9.0	0.0	11.0	11.0	10.0	10.0	10.1	5.9	50.0
	V	16.0	16.0	16.0	16.0	12.6	1.0	12.3	11.5	15.0	15.0	14.0	14.0	12.8	8.1	61.0
	VI	24.0	24.0	22.0	22.0	17.1	6.4	16.3	5.2	20.0	20.0	19.2	19.2	15.5	10.0	70.0
104	IV	9.8	9.8	10.2	10.2	0.0	7.9	0.0	7.8	9.0	9.0	8.5	8.5	8.5	5.8	44.5
	V	12.5	12.5	13.0	13.0	0.75	9.5	0.25	10.0	11.5	11.5	11.0	11.0	11.0	7.1	57.0
	VI	15.5	15.5	16.5	15.8	3.0	11.8	3.1	12.2	14.5	14.5	14.0	14.0	14.0	9.0	72.5
	VII	18.1	18.1	19.2	18.5	8.3	14.4	9.4	15.0			16.6	16.6	16.2	10.5	78.0

No.	Instar	Fore legs						Mid-legs						Hind legs						Meso	Meta
		Tibia		Femur		L	R	Tibia		Femur		L	R	Tibia		Femur		L	R		
		L	R	L	R			L	R	L	R			L	R	L	R			L	R
200	III	7.0	7.0	8.0	8.0	0.25	6.0	0.25	6.0	0	0.25	0	0.25	0	0.25	0	0.25	6.2	4.0		
	IV	10.2	10.2	10.3	10.3	2.0	8.0	2.2	7.8	0.3	0.4	0.3	0.4	0.3	0.4	0.3	0.4	8.2	5.4		
	V	12.9	12.9	13.0	13.0	3.2	9.8	6.0	9.5	0.85	2.0	0.85	2.2	0.85	2.2	0.85	2.2	10.8	6.8		
	VI	17.1	17.1	17.0	17.0	6.6	12.4	10.0	12.0	3.6	7.0	3.2	8.0	3.6	7.0	3.2	8.0	13.0	8.6		
	VII	21.0	22.2	22.0	22.0	11.0	14.8	14.0	15.0	8.6	11.6	9.8	14.0	8.6	11.6	9.8	14.0	17.0	10.0		
	III	7.6	7.6	8.4	8.4	6.0	6.0	6.0	6.0	0.15	0.1	0.15	0.1	0.15	0.1	0.15	0.1	6.8	4.0		
	IV	10.0	10.0	11.0	11.0	8.0	8.0	7.8	7.8	0.7	0.15	0.7	0.15	0.7	0.15	0.7	0.15	9.0	5.5		
201	V	13.0	13.0	15.0	15.0	10.0	10.0	10.5	10.5	8.0	0	7.8	0	8.0	0	7.8	0	11.0	6.5		
	VI	21.2	21.2	22.0	22.0	15.0	15.0	15.0	15.0	15.0	0	15.4	0	15.0	0	15.4	0	15.0	9.5		
	III	7.0	7.0	8.0	8.0	6.5	6.5	5.5	5.5	0.25	0.0	0.25	0.0	0.25	0.0	0.25	0.0	6.2	4.0		
	IV	10.8	10.8	10.5	10.5	8.0	8.0	7.8	7.8	0.45	0.25	0.45	0.25	0.45	0.25	0.45	0.25	9.0	6.0		
	V	13.6	13.6	14.1	14.1	10.0	10.0	10.4	10.4	2.0	1.2	2.5	1.2	2.0	1.2	2.5	1.2	12.0	7.0		
	VI	17.0	17.0	17.5	17.5	12.6	12.6	12.6	12.6	6.8	4.1	7.1	5.0	6.8	4.1	7.1	5.0	14.0	9.2		
	VII	22.0	22.0	21.0	21.0	15.8	15.8	16.0	16.0	12.0	8.2	12.5	10.0	12.0	8.2	12.5	10.0	18.0	11.4		
202	III	6.5	6.5	7.0	7.0	5.5	0	5.4	0	6.8	6.8	6.0	6.0	6.0	6.0	6.0	6.0	6.0	4.0		
	IV	9.0	9.0	9.0	9.0	7.4	0	7.2	0	8.9	8.9	8.0	8.0	8.0	8.0	8.0	8.0	7.8	5.0		
	V	12.0	12.0	12.0	12.0	9.5	0	9.6	0	11.0	11.0	10.0	10.0	11.0	11.0	10.0	10.0	10.8	7.0		
	VI	16.8	16.8	16.0	16.0	11.5	0	11.0	0	14.5	14.5	13.0	13.0	14.5	14.5	13.0	13.0	14.0	9.0		
	VII	22.0	22.0	21.0	21.0	15.8	15.8	16.0	16.0	12.0	8.2	12.5	10.0	12.0	8.2	12.5	10.0	18.0	11.4		
	III	6.5	6.5	7.0	7.0	5.5	0	5.4	0	6.8	6.8	6.0	6.0	6.0	6.0	6.0	6.0	6.0	4.0		
	IV	9.0	9.0	9.0	9.0	7.4	0	7.2	0	8.9	8.9	8.0	8.0	8.0	8.0	8.0	8.0	7.8	5.0		
203	V	12.0	12.0	12.0	12.0	9.5	0	9.6	0	11.0	11.0	10.0	10.0	11.0	11.0	10.0	10.0	10.8	7.0		
	VI	16.8	16.8	16.0	16.0	11.5	0	11.0	0	14.5	14.5	13.0	13.0	14.5	14.5	13.0	13.0	14.0	9.0		
	VII	22.0	22.0	21.0	21.0	15.8	15.8	16.0	16.0	12.0	8.2	12.5	10.0	12.0	8.2	12.5	10.0	18.0	11.4		
	III	6.5	6.5	7.0	7.0	5.5	0	5.4	0	6.8	6.8	6.0	6.0	6.0	6.0	6.0	6.0	6.0	4.0		
	IV	9.0	9.0	9.0	9.0	7.4	0	7.2	0	8.9	8.9	8.0	8.0	8.0	8.0	8.0	8.0	7.8	5.0		
	V	12.0	12.0	12.0	12.0	9.5	0	9.6	0	11.0	11.0	10.0	10.0	11.0	11.0	10.0	10.0	10.8	7.0		
	VI	16.8	16.8	16.0	16.0	11.5	0	11.0	0	14.5	14.5	13.0	13.0	14.5	14.5	13.0	13.0	14.0	9.0		

204	III	6.3	6.3	6.5	6.5	0	6.0	0	5.6	7.0	7.0	5.8	5.8	6.0	4.0
	IV	9.0	9.0	9.0	9.0	0.25	7.2	0.25	7.0	8.5	8.5	7.8	7.8	8.0	5.0
	V	12.0	12.0	12.0	12.0	1.2	9.3	1.2	9.0	11.0	11.0	10.0	10.0	10.6	7.0
	VI	15.5	15.5	16.5	16.5	3.5 (0.35)	11.5	2.2	12.0	13.3	13.3	13.0	13.0	14.0	9.0
	VII	19.5	19.5	18.5	18.5	6.0 (1.0)	14.0	2.6	14.0	17.1	17.0	16.2	16.2	16.5	10.6
						1.2 (1.2)	2.5								
	III	7.5	7.5	8.0	8.0	0.2	6.2	0.2	6.1	0	8.0	0	6.8	7.0	4.0
205	IV	11.0	11.0	11.5	11.5	1.5	8.2	1.9	9.0	0.25	10.2	0.25	9.4	9.5	6.0
	V	15.0	15.0	15.0	15.0	2.0	11.0	5.0	11.0	2.6 (0.7)	13.5 (2.8)	2.6	12.5	12.0	8.2
	VI	22.0	22.0	21.0	21.0	6.0	15.5	11.5	15.3	10.0 (2.0)	20.0 (3.6)	9.5	18.0	15.0	10.0
	III	7.2	6.9	8.0	8.0	6.2	6.2	6.0	6.0	7.1	0	7.0	0	6.6	4.2
	IV	10.5	10.5	11.0	11.0	8.5	8.5	8.0	8.0	10.0	0	9.5	0	6.0	6.2
206	V	14.0	14.0	14.0	14.0	10.5	10.5	11.0	11.0	12.8	0	12.0	0	11.8	8.0
	VI	20.2	21.2	20.2	20.2	15.5	15.5	16.2	16.2	19.0	0	18.0	0	15.0	9.5
	III	7.0	7.1	7.2	7.4	6.1	6.1	6.0	6.0	7.0	0	6.1	0	6.5	4.5
	IV	9.2	9.2	10.0	10.0	8.0	8.0	8.0	8.0	9.9	0	8.2	0	9.0	6.0
207	V	12.0	12.0	13.0	13.0	10.2	10.2	10.2	10.2	12.0	0	11.2	0	11.0	7.5
	VI	16.2	16.2	17.5	17.5	12.0	12.0	13.0	13.0	14.8	0	14.0	0	14.0	9.4
	VII	21.2	21.2	21.5	21.5	16.0	16.0	16.4	16.4	19.0	0	17.5	0	17.5	11.2

208	III	7.5	7.5	8.4	8.4	6.5	6.5	5.9	5.9	0	0	0	0	7.0	4.8
	IV	11.0	11.0	11.2	11.2	9.0	9.0	8.0	8.0	0.25	0	0.25	0	10.0	6.5
	V	15.2	15.2	15.5	15.5	11.5	11.5	11.2	11.2	1.5	0	1.9	0	12.5	8.2
	VI	22.5	22.5	21.5	21.5	16.0	16.0	15.5	15.5	(0.5) 7.0	0	7.2	0	15.5	10.0
209	III	7.0	7.0	8.0	8.0	6.2	6.2	5.2	5.2	7.1	0	6.8	0	7.0	4.2
	IV	10.0	10.0	10.0	10.0	8.4	8.4	8.0	8.0	10.0	0	8.6	0	9.5	6.1
	V	12.5	12.5	13.0	13.0	10.0	10.0	10.0	10.0	11.8	0.1	10.5	0.1	11.5	7.8
	VI	15.8	15.8	16.5	16.5	12.0	12.0	12.0	12.0	15.0	0.6	12.5	0.5	14.2	9.4
210	VII	20.2	20.2	21.0	21.0	15.0	15.0	16.0	16.0	19.0	0	17.0	0	18.2	12.5
	III	7.0	7.0	7.0	7.0	0	5.8	0	5.4	7.0	7.0	6.5	6.5	6.8	4.1
	IV	10.0	10.0	10.0	10.0	0	7.8	0	7.8	10.0	10.0	8.6	8.6	9.0	5.8
	V	12.5	12.5	13.0	13.0	0	9.2	0	9.5	11.5	11.5	10.5	10.5	11.5	7.0
211	VI	15.5	15.5	16.0	16.0	0	11.8	0	12.0	15.0	15.0	13.1	13.1	14.0	9.2
	III	6.4	0	7.5	0	5.8	5.8	5.8	5.8	7.1	7.1	6.5	6.5	6.2	4.0
	IV	9.0	0.4	9.8	0.6	7.0	7.0	8.0	8.0	9.0	9.0	9.2	9.2	8.0	5.8
	V	12.4	1.4	13.5	2.2	9.5	9.5	10.0	10.0	11.2	11.2	11.2	11.2	11.2	7.8
211	VI	16.8	5.0	17.8	8.5	12.8	12.8	12.8	12.8	15.0	15.0	14.0	14.0	14.4	10.8
	VII	22.0	10.1	21.0	13.5	15.0	15.0	15.0	15.0	20.0	20.0	17.0	17.0	18.0	12.0

(3.8) (1.0)

212	III	7.1	1.1	7.5	7.5	5.6	5.6	5.4	5.4	7.0	0	6.2	0	6.2	4.0
	IV	9.0	9.0	10.0	10.0	7.8	7.8	7.5	7.5	9.0	0	8.0	0	8.5	5.8
	V	12.0	12.0	12.6	12.6	9.5	9.5	9.0	9.0	10.7	0	10.4	0	10.6	7.0
	VI	15.2	15.2	15.2	15.2	11.4	11.4	11.0	11.0	14.0	0	13.0	0	13.0	8.8
	VII	19.0	19.0	19.0	19.0	14.0	14.0	14.4	14.4	17.0	0	16.0	0	17.0	11.0
	III	7.0	7.0	7.4	7.4	6.0	0	6.0	0	8.0	8.0	6.7	6.7	6.8	4.2
	IV	10.0	10.0	11.0	11.0	8.5	0	8.0	0	10.0	10.0	9.0	9.0	9.1	6.4
213	V	14.2	13.5	14.0	13.8	10.9	0	11.0	0	13.0	13.0	12.0	12.0	12.0	8.0
	VI	22.8	22.8	20.0	20.0	15.3	0	15.0	0	19.0	19.0	17.8	17.8	15.8	10.0
	III	7.0	7.0	8.0	8.0	6.5	6.5	6.0	6.0	0	7.5	0	6.5	6.5	4.2
	IV	11.0	11.0	11.4	11.4	8.2	8.2	8.3	8.3	0	10.0	0	9.0	9.2	6.2
214	V	13.0	13.0	14.0	14.0	10.0	10.0	10.0	10.0	0	12.0	0	11.5	12.0	8.1
	VI	17.0	17.0	17.0	17.0	12.5	12.5	12.6	12.6	0	15.6	0	16.0	14.5	9.9
	VII	21.0	21.0	22.0	22.0	15.0	15.0	16.2	16.2	0	19.0	0	19.0	18.0	12.0
	III		7.0	7.0	7.0	5.4	0	5.2	4.9	7.0	7.0	6.0	6.0	6.4	4.0
215	IV	0.1	10.0	0.1	10.0	8.0	0.3	7.8	6.0	9.0	9.0	8.6	8.6	9.0	5.8
	V		14.0		14.0	11.0	0.5	10.6	7.0	12.6	12.6	12.4	12.4	12.0	7.5
	VI		20.3		19.0	15.0	0	15.0	8.4	18.8	18.8	17.2	17.2	15.6	10.0

216	III	7.8	7.8	8.0	8.0	6.5	6.5	6.4	6.4	0	8.0	0	7.0	7.0	4.0
	IV	10.0	10.0	10.2	10.2	7.2	6.2	6.2	6.2	0	9.2	0	9.0	8.5	6.0
	V	14.0	14.0	14.4	14.4	11.5	11.5	10.5	10.5	0	13.1	0	11.6	12.0	7.8
	VI	16.2	16.2	16.5	16.5	12.6	12.6	12.6	12.6	1.2	1.6	1.5	14.0	14.0	9.9
	VII	21.5	21.5	21.5	21.5	15.2	15.2	17.0	17.0	0	20.0	0	19.0	17.4	11.5
	III	7.0	7.0	8.0	8.0	6.1	6.1	6.0	6.0	0	7.0	0	6.3	7.0	4.2
	IV	9.4	9.4	11.2	11.2	7.8	7.8	8.0	8.0	0	9.0	0	9.0	8.8	6.0
217	V	13.0	13.0	13.8	13.8	10.0	10.0	10.0	10.0	0	12.5	0	12.0	12.0	8.0
	VI	18.0	18.0	17.0	17.0	14.0	14.0	13.0	13.0	0	17.0	0	15.0	15.2	10.0
	VII	23.0	23.0	22.2	21.8	17.0	17.0	17.0	17.0	0	21.0	0	19.2	19.0	12.0
	IV	11.6	11.0	12.0	12.0	8.5	8.5	8.0	8.0	11.0	0.25	9.0	0.25	9.4	6.5
	V	16.0	16.0	15.5	15.5	11.5	11.5	11.4	11.4	15.0	1.0	13.0	1.5	12.0	8.0
	VI	25.9	25.9	22.5	22.5	18.0	18.0	16.4	16.4	22.4	4.0	20.0	4.0	15.0	10.0
										(4.0)	(1.8)				
218	IV	10.7	10.7	11.0	11.0	0.7	8.0	1.0	8.0	0.6	9.6	0.7	8.7	10.0	6.1
	V	14.2	14.2	15.0	15.0	2.8	11.0	3.0	11.5	1.5	12.2	1.8	12.0	12.4	7.8
	VI	21.2	21.2	21.2	21.2	(0.7)	(2.2)	8.5	15.2	(0.4)	(2.8)	1.9	18.0	16.0	9.2
						(1.8)	(3.0)			4.0	19.0				
	IV	11.0	11.0	11.2	11.2	0.3	9.0	0.3	9.0	10.5	10.5	9.5	9.5	9.4	6.4
	V	16.0	16.0	16.0	16.0	2.0	12.0	1.7	11.8	14.0	14.0	13.0	13.0	12.0	8.0
	VI	25.0	25.0	22.0	22.0	(0.6)	(2.5)	3.5	17.8	21.5	21.5	18.5	18.5	14.0	9.0
						(1.6)	(3.5)								
219	IV	10.7	10.7	11.0	11.0	0.7	8.0	1.0	8.0	0.6	9.6	0.7	8.7	10.0	6.1
	V	14.2	14.2	15.0	15.0	2.8	11.0	3.0	11.5	1.5	12.2	1.8	12.0	12.4	7.8
	VI	21.2	21.2	21.2	21.2	(0.7)	(2.2)	8.5	15.2	(0.4)	(2.8)	1.9	18.0	16.0	9.2
						(1.8)	(3.0)			4.0	19.0				
	IV	11.0	11.0	11.2	11.2	0.3	9.0	0.3	9.0	10.5	10.5	9.5	9.5	9.4	6.4
	V	16.0	16.0	16.0	16.0	2.0	12.0	1.7	11.8	14.0	14.0	13.0	13.0	12.0	8.0
	VI	25.0	25.0	22.0	22.0	(0.6)	(2.5)	3.5	17.8	21.5	21.5	18.5	18.5	14.0	9.0
						(1.6)	(3.5)								
220	IV	10.7	10.7	11.0	11.0	0.7	8.0	1.0	8.0	0.6	9.6	0.7	8.7	10.0	6.1
	V	14.2	14.2	15.0	15.0	2.8	11.0	3.0	11.5	1.5	12.2	1.8	12.0	12.4	7.8
	VI	21.2	21.2	21.2	21.2	(0.7)	(2.2)	8.5	15.2	(0.4)	(2.8)	1.9	18.0	16.0	9.2
						(1.8)	(3.0)			4.0	19.0				
	IV	11.0	11.0	11.2	11.2	0.3	9.0	0.3	9.0	10.5	10.5	9.5	9.5	9.4	6.4
	V	16.0	16.0	16.0	16.0	2.0	12.0	1.7	11.8	14.0	14.0	13.0	13.0	12.0	8.0
	VI	25.0	25.0	22.0	22.0	(0.6)	(2.5)	3.5	17.8	21.5	21.5	18.5	18.5	14.0	9.0
						(1.6)	(3.5)								

221	IV	10.3	10.3	10.5	8.5	8.5	7.6	7.6	0.23	0.25	0.23	0.25	9.0	6.0
	V	14.0	14.0	14.2	11.0	11.0	10.8	10.8	2.0	2.0	2.0	2.0	11.5	8.0
	VI	18.0	18.0	18.5	13.0	14.0	12.5	12.5	6.0	1.9	7.0	8.0	14.5	10.0
	VII	24.3	24.3	23.0	16.8	16.8	16.0	16.0	12.8	1.4	13.0	10.5	17.2	11.6
222	IV	11.2	11.2	12.0	9.0	9.0	8.5	8.5	0.4	0.4	0.4	0.4	9.2	6.5
	V	16.5	16.5	16.5	12.3	12.3	12.0	12.0	3.0	1.6	3.0	2.5	11.2	8.0
	VI	25.9	25.9	22.3	18.0	18.0	17.0	17.0	(0.5) 10.0 (1.7)	(0.3) 7.0 (1.7)	11.0	8.0	15.0	10.0
223	IV	9.0	9.0	9.6	7.5	7.5	7.4	7.4	8.5	0.35	8.0	0.35	8.2	5.2
	V	12.0	12.0	12.6	9.0	9.0	9.5	9.5	11.1	2.2	10.5	3.0	10.6	7.0
	VI	16.0	16.0	16.9	11.8	11.8	12.0	12.0	(2.5) 15.2 (3.0)	(0.7) 9.0 (2.0)	13.2	8.4	14.0	10.0
	VII	21.6	21.6	20.5	15.0	15.0	16.0	16.0	19.0 (3.2)	16.0 (2.8)	17.0	13.0	17.6	11.6
224	IV	10.9	10.9	11.2	8.5	8.5	9.0	9.0	0.25	10.4	0.25	10.0	9.5	6.3
	V	16.0	16.0	16.0	11.4	11.5	11.0	11.0	1.25	14.0	1.2	13.8	12.6	8.0
	VI	24.0	24.0	23.8	17.5	17.5	17.4	17.4	6.5	22.0	6.4	20.2	15.8	10.1
225	IV	10.0	10.0	10.0	7.5	7.5	7.5	7.5	9.2	0.25	8.0	0.25	8.6	5.5
	V	13.0	13.0	13.4	9.8	9.8	9.8	9.8	11.4	2.6	10.4	2.2	11.0	7.0
	VI	15.9	15.9	16.0	12.5	12.5	12.1	14.0	(2.1) 14.5 (2.9)	(0.7) 9.5 (2.0)	13.5	8.6	14.0	9.0
	VII	19.6	19.6	19.0	14.9	14.9	15.0	15.0	18.0 (3.0)	16.0 (3.0)	17.0	14.0	18.0	12.0

226	IV	10.0	10.0	10.0	10.0	8.0	8.0	8.0	0.25	0.35	0.5	0.35	8.9	5.6
	V	13.0	13.0	13.0	13.0	10.0	9.0	10.0	1.4	2.0	2.5	2.5	11.0	7.1
	VI	17.0	17.0	17.0	17.0	13.0	11.9	12.5	3.0	8.5	8.0	8.0	14.0	9.0
	VII	21.0	21.0	21.5	21.5	14.0	14.0	15.8	6.1	15.0	13.0	13.8	17.0	10.0
227	V	12.0	12.0	13.5	13.5	0	10.2	0	10.2	12.0	12.0	11.3	10.8	7.0
	VI	16.4	16.4	16.2	16.2	2.2	12.8	3.0	12.8	15.0	15.0	14.0	14.0	9.0
	VII	20.5	20.5	20.0	20.0	9.0	16.0	9.0	16.0	19.0	19.0	18.0	16.0	10.8
	V	12.0	12.0	13.1	13.1	10.5	10.5	10.0	10.0	12.0	0	11.0	0	6.3
228	VI	17.5	17.5	17.0	17.0	13.2	13.2	12.9	12.9	15.2	0	14.0	0	8.0
	VII	20.0	22.0	20.5	20.5	16.0	16.0	16.0	16.0	20.2	0	19.0	0	10.0
	V	13.0	13.0	13.9	13.9	10.0	10.0	10.5	10.5	12.8	0.3	11.0	0.3	6.4
229	VI	16.0	16.0	17.0	17.0	13.5	13.5	12.9	12.9	16.2	2.4	14.5	2.6	8.5
	VII	22.4	22.4	20.2	20.2	16.5	16.5	15.8	15.8	19.5		17.0	16.5	9.8
	V	13.0	13.0	13.0	13.0	10.0	10.0	10.0	10.0	0.2	0	0.2	0	7.0
230	VI	17.0	17.0	17.0	17.0	12.2	12.2	13.0	13.0	7.0	0.5	7.0	0.5	9.1
	VII	23.0	23.0	19.0	19.0	16.0	16.0	15.4	15.4	21.0	9.0	18.0	9.4	9.0
	V	11.5	11.5	12.5	12.5	9.0	0	9.4	0	0	11.5	0	11.0	7.0
231	VI	15.8	15.8	16.2	16.2	11.4	0.25	12.0	0.25	1.8	14.0	1.5	13.0	8.4

	V	0	0	0	0	10.0	10.0	10.0	10.0	10.0	12.8	0.25	11.0	0.25	11.0	7.5
232	VI	0.25	0.25	0.25	0.25	13.0	13.0	12.5	12.5	12.5	16.0	0.5	14.0	2.2	14.0	9.8
	VII	0.3	0.3	0.25	0.12	15.0	15.0	16.0	16.0	16.0	20.0	1.7	18.0	6.5	17.0	11.5
233	V	12.0	12.0	13.4	13.4	0	0	0	0	0	13.6	0	11.5	0	11.5	7.8
	VI					1.7	1.7	2.0	1.7	1.7	16.8	0	15.0	0	15.0	10.5
	V	13.0	13.0	14.0	14.0	9.5	9.5	10.0	10.0	10.0	7.0	0.2	6.2	0.2	12.0	8.0
234	VI	15.0	15.0	18.0	18.0	12.5	12.5	13.2	13.2	13.2	11.0	3.8	10.6	3.4	16.0	10.4
	VII	21.3	21.3	22.5	22.5	15.6	15.6	17.0	17.0	17.0	16.0	9.2	15.0	10.0	19.5	13.0
											(2.8)	(2.0)				
235	VI	0.25	16.0	0.25	16.0	11.5	11.5	11.3	11.3	11.3	14.0	14.0	13.5	13.5	12.6	8.0
	VII	0.5	25.0	0.7	23.0	17.0	18.0	16.0	16.0	16.0	21.5	21.5	19.0	19.0	15.5	10.1
	V	12.0	12.0	12.4	12.4	9.6	9.6	9.4	9.4	9.4	12.0	0.0	10.6	0.0	10.7	7.0
236	VI	16.9	16.9	17.0	17.0	12.0	12.0	12.5	12.5	12.5	16.0	0.0	13.6	0.0	14.0	9.0
	VII	20.0	20.0	20.5	20.5	15.0	15.0	15.0	15.0	15.0	20.0	0.0	17.0	0.0	17.2	11.0
	V	10.7	10.7	11.5	11.5	9.5	9.5	8.9	8.9	8.9	0.0	10.4	0.0	9.9	10.0	6.8
237	VI	14.0	14.0	15.1	15.1	11.0	11.0	11.0	11.0	11.0	1.7	13.4	2.0	12.0	13.0	8.8
	VII	18.5	18.5	18.2	18.2	13.5	13.5	14.2	14.2	14.2	(0.5)	(2.0)	7.8	15.5	15.5	10.6
											(1.0)	(3.0)				
238	V	14.0	14.0	15.0	15.0	10.1	10.1	11.0	11.0	11.0	12.4	0.0	12.0	1.8	12.0	8.0
	VI	20.5	20.5	20.5	20.5	15.0	15.0	15.0	15.0	15.0	17.5	4.2	17.4	6.0	16.0	9.5

239	II	5.5	5.5	5.8	5.8	0.15	0.0	0.15	0.0	5.5	5.5	5.0	5.0	3.2
	III	7.2	7.2	8.0	8.0	1.25 (0.3)	0.5	1.25	0.5	7.5	7.5	6.8	6.8	4.2
	IV	10.5	10.5	11.0	11.0	4.5 (0.9)	1.6 (0.5)	4.5	1.8	10.3	10.3	9.0	10.0	6.0
	V	15.0	14.8	15.0	15.0	9.0 (2.0)	7.0 (1.4)	8.8	7.0	13.2	13.2	12.4	12.0	7.8
	VI	22.0	22.0	21.0	21.0	14.5 (3.0)	14.0 (2.4)	14.0	13.8	20.0	18.5	18.0	15.0	9.0
	II	0.15	5.0	0.15	5.2	4.0	4.0	5.0	5.0	5.5	0.0	5.0	5.0	3.0
240	III	1.2 (0.4)	7.0 (1.5)	1.4	7.5	6.0	6.0	6.0	6.0	6.9	0.1	6.1	0.1	4.3
	IV	4.4 (1.1)	9.7 (2.0)	5.0	10.0	7.2	7.2	7.4	7.4	9.6 (2.0)	1.7 (0.5)	8.2	2.0	6.2
	V	9.5 (2.4)	12.4 (3.0)	10.5	13.2	9.0	9.5	9.0	9.0	11.5 (3.0)	7.5 (1.6)	10.4	5.4	7.5
	VI	13.5 (2.1)	15.4 (2.6)	14.4	16.5	11.0	11.9	11.5	11.5	14.0 (2.6)	10.0 (2.4)	13.5	9.4	9.0
	VII	19.0 (3.1)	20.0 (3.1)	19.5	20.5	13.5	14.5	14.0	15.0	18.0	16.5	17.0	17.0	11.0
	II	0.25	5.6	0.25	6.0	4.8	0.0	4.2	0.0	5.8	5.8	5.0	5.0	3.0
	III	1.8 (0.35)	7.8 (2.0)	1.8	8.0	7.0	1.4	6.2	1.4	8.0	8.0	7.0	7.0	4.3
241	IV	5.2 (1.5)	10.8 (2.5)	6.0	10.9	9.1 (1.7)	2.0 (0.8)	8.0	2.0	11.0	11.0	9.1	9.1	6.0
	V	11.0 (2.6)	15.0 (3.0)	11.0	14.6	11.5 (2.5)	7.0 (2.0)	11.0	7.0	0	14.2	0	13.0	7.6
	VI	21.0 (3.8)	24.0 (4.0)	17.9	20.0	18.0 (3.2)	14.2 (3.0)	15.0	15.0	0	22.8	0	19.3	9.0
	II	5.0	5.0	5.5	5.5	0	4.6	0	4.5	5.1	0.12	5.0	0.12	3.0
243	III	7.0	7.0	8.5	8.5	0.12	6.4	0.12	6.5	7.1 (1.8)	1.2 (0.4)	6.6	1.2	4.6
	IV	10.0	10.0	11.0	11.0	2.0	9.0	2.1	8.6	10.8 (2.1)	4.4 (1.5)	9.2	5.2	6.0

243	V	14.5	14.5	15.2	15.2	8.0 (2.0)	11.0 (2.5)	8.0	11.5	13.0 (3.0)	10.0 (2.4)	12.8	10.5	11.6	8.0
	VI	22.5	22.5	21.8	21.8	15.0 (3.0)	17.0 (3.0)	15.2	16.0	20.0 (4.1)	18.0 (3.1)	18.4	17.4	14.4	9.1
	II	4.5	4.5	5.0	5.0	0.12	0	0.12	0	5.1	5.1	4.2	4.2	4.5	3.0
	III	6.0	6.0	6.8	6.8	1.2 (0.4)	0.25	1.2	0.25	6.5	6.5	5.8	5.8	6.0	4.0
244	IV	8.5	7.0	9.0	8.0	2.0 (0.7)	4.2 (1.0)	2.8	2.8	8.1	8.1	7.5	7.5	8.0	5.2
	V														
	VI	14.5	14.5	14.7	14.7	9.1 (2.0)	9.1 (2.0)	10.0	9.0	12.8	12.8	13.0	13.0	13.0	8.0
	VII	18.0	18.0	18.2	18.2	13.0 (2.3)	12.0 (2.3)	12.5	12.5	17.0	17.0	16.0	16.0	15.7	10.0
	II	0.25	4.5	0.25	5.0	4.0	4.0	4.3	4.3	4.5	0	4.0	0	4.5	3.0
	III	1.0 (0.2)	6.2	1.5	7.0	5.8	5.8	5.6	5.6	6.0	0.25	6.0	0.25	6.4	4.0
245	IV	4.6 (1.1)	8.5 (1.9)	5.6	9.0	7.0	7.0	7.0	7.0	8.0 (2.0)	2.5 (0.5)	7.6	2.5	8.0	5.2
	V	9.2 (2.0)	11.0 (2.1)	10.0	11.9	8.2	8.2	9.5	9.5	10.5	7.0	10.4	7.0	10.8	7.5
	VI	14.0 (2.5)	14.2 (3.0)	15.0	15.6	10.9	10.9	12.0	12.0	13.0	11.2	13.0	11.5	14.0	9.9
	VII	20.0 (3.5)	19.5 (3.5)	20.0	21.0	14.0	14.0	16.0	16.0	17.0	15.0	17.0	16.0	17.2	12.0
	II	5.8	5.8	6.0	6.0	4.8	4.8	5.0	5.0	0	0.25	0	0.25	5.0	3.1
	III	8.0	8.0	8.2	8.2	6.5	6.5	6.5	6.5	0.25	1.5 (0.3)	0.25	1.2	7.0	4.5
246	IV	11.0	11.0	10.5	10.5	8.0	8.0	8.5	8.5	2.3 (0.7)	5.0 (1.6)	2.3	5.0	8.8	6.0
	V	15.0	14.0	14.5	14.5	11.6	11.6	11.0	11.0	9.2 (2.4)	10.1 (2.6)	8.2	7.8	12.0	7.6
	VI	21.0	21.0	20.8	20.8	16.0	16.0	16.0	16.0	17.0 (3.0)	17.0 (3.0)	15.5	15.5	15.0	9.0

247	II	4.4	4.4	5.0	5.0	0.17	4.5	0.17	4.0	4.9	0	4.3	0	4.2	3.0
	III	6.2	6.2	7.0	7.0	1.2 (0.5)	5.4	1.2	6.1	6.5	0.17	6.0	0.17	5.8	3.9
	IV	8.5	8.5	9.0	9.0	5.0 (1.5)	7.3	5.0	7.6	8.5	0.2	7.8	0.2	7.8	5.0
	V	11.5	11.5	12.0	12.0	8.2 (1.8)	9.1	7.5	9.0	10.6	0.5	9.5	0.7	10.6	7.0
	VI	15.0	15.0	15.0	15.0	11.9 (2.0)	12.0	11.0	12.0	13.0	2.4 (0.9)	12.4	3.0	13.0	9.0
	VII	19.0	19.0	19.0	19.0	15.8 (3.0)	14.4	15.0	15.0	17.0	0	15.0	0	16.0	11.0
	IV	8.0	8.4	9.0	8.9	1.8 (0.5)	3.2	1.8	4.0	8.0	8.0	8.0	8.0	7.0	5.0
248	V	11.0	11.0	11.8	11.8	7.1 (2.0)	5.9	6.9	5.9	10.5	10.5	10.0	10.0	10.0	7.0
	VI	13.8	13.8	15.0	15.0	10.2 (2.3)	10.0	11.0	5.5	13.2	13.2	12.5	12.5	13.4	8.8
	VII	18.5	17.5	18.6	17.1	13.8 (2.3)	0	14.0	0	15.0	15.0	15.2	15.2	16.0	10.5
	II	5.5	5.5	5.5	5.5	5.0	0	4.8	0	0.12	5.8	0.12	5.0	5.0	3.2
249	III	7.5	7.5	8.0	8.0	6.8	0.35	6.5	0.35	0.15	0	0.15	0	6.6	4.2
	IV	0	10.8	0	10.8	9.0 (1.8)	2.0	8.5	2.0	9.0	0.4	9.8	1.0	8.8	5.5
	V	1.4	14.5	1.5	14.5	11.0 (2.2)	7.2	10.9	7.0	12.0	1.0	13.8	3.2	11.0	7.0
	VI	6.1 (1.2)	21.8 (3.6)	6.0	21.0	14.8 (3.0)	12.5	14.0	12.4	17.0 (2.5)	1.8	18.0	11.5	14.0	9.0
	II	5.0	5.0	5.5	5.5	0.25	0	0.25	0	5.7	5.7	5.5	5.5	4.3	3.0
	III	6.4	6.4	7.0	7.0	1.0 (0.3)	0.2	1.4	0.2	0	7.0	0	6.5	6.0	4.0
250	IV	9.0	9.0	10.0	10.1	3.4 (1.0)	2.0	4.1	2.0	0.25	9.0 (2.0)	0.25	8.5	8.0	5.2
	V	12.8	12.8	13.0	13.0	6.8 (1.4)	5.5	7.0	6.0	2.0 (0.6)	12.0 (2.2)	2.0	10.9	11.0	7.5

250	VI	15.6	15.6	16.8	16.8	9.2 (1.9)	9.0 (1.9)	10.0	9.8	5.0 (0.5)	14.9 (2.5)	6.5	13.5	13.2	9.0
	VII	20.0	21.0	21.0	21.0	12.5 (2.1)	12.5 (2.1)	13.0	13.0	9.5 (0.5)	18.0 (3.1)	13.5	17.0	17.0	11.0
251	II	0	5.4	0	5.5	4.9	4.9	4.9	4.9	6.5	0.25	5.0	0.25	5.0	3.0
	III	0.25	8.0	0.25	8.0	6.8	6.8	6.1	6.1	0	1.4 (0.5)	0	1.4	7.0	4.0
	IV	2.0 (0.7)	10.8 (2.5)	2.0	10.8	9.0	9.0	8.2	8.2	0.25	5.3 (1.5)	0.25	4.5	9.0	5.5
	V	8.0 (2.2)	15.0 (3.0)	8.0	15.0	11.5	11.5	10.5	10.5	2.6 (1.0)	10.5 (2.0)	2.4	9.0	11.3	7.5
	VI	16.0 (3.8)	23.1 (4.0)	15.0	20.2	16.0	16.0	15.0	15.0	11.4 (2.2)	16.6 (3.0)	10.0	14.5	14.3	9.0
252	II	5.4	5.4	5.6	5.6	5.0	5.0	5.0	5.0	0.25	0	0.25	0	5.0	3.0
	III	7.0	7.0	8.0	8.0	0	6.0	0	6.0	1.8	0.5	1.9	0.5	6.2	4.0
	IV	10.9	10.9	11.0	11.0	0.25	8.9	0.25	8.2	5.5 (1.5)	2.1 (0.6)	4.9	2.3	8.6	6.0
	V	13.5	13.5	14.0	14.0	3.0 (1.0)	10.2 (2.0)	2.9	10.5	10.0 (2.0)	8.0 (1.8)	9.2	7.0	11.0	7.3
	VI	17.8	17.2	17.9	17.1	8.4 (2.0)	13.0 (2.5)	9.0	13.9	14.0 (3.0)	12.5 (2.7)	13.0	11.8	14.1	10.0
	VII	22.0	22.0	21.4	21.4	14.0 (3.0)	16.0 (3.0)	14.0	17.0	17.0 (2.9)	17.0 (2.9)	17.0	16.8	18.0	12.0
253	II	5.0	5.0	5.5	5.5	4.5	0.25	4.9	0.25	0	5.5	0	5.0	5.0	3.0
	III	0	6.5	0	7.0	5.7 (1.2)	1.4 (0.5)	5.5	1.5	0.3	6.8	0.3	6.0	6.0	3.6
	IV	1.5	14.0 (2.8)	1.8	14.5	11.0 (2.0)	7.2 (1.1)	10.8	7.0	0.5 (0.5)	13.0 (2.8)	3.1	11.8	11.0	7.4
254	II	5.0	0	5.6	0	4.6	4.6	4.5	4.5	0.25	6.0	0.25	5.3	4.5	3.2
	III	7.5	0.1	8.0	0.1	0	6.4	0	6.4	1.6 (0.3)	7.5 (1.9)	1.6	6.9	6.8	4.0

254	IV	11.0 (2.3)	1.6	11.0	1.9	0.25	9.3	0.25	8.6	5.0 (1.2)	11.0 (2.4)	5.5	9.4	8.8	5.8
	V	15.6 (3.0)	5.0	15.6	7.0	2.0	12.0 (2.2)	3.0	11.2	9.8 (2.0)	15.3 (3.0)	10.0	13.3	11.5	7.5
	VI	19.5 (3.0)	11.2 (0.8)	18.3	13.8	3.0	17.0 (3.0)	9.0	15.0	16.2 (2.1)	22.0 (3.1)	16.0	18.2	13.8	9.0
	II	5.0	5.0	6.0	6.0	4.6	4.6	4.3	4.3	0	0.25	0	0.25	5.2	3.0
255	III	7.5	7.5	8.0	8.0	6.5	0	6.4	0	0.25	1.5 (0.3)	0.25	1.2	6.5	4.0
	IV	10.0	10.0	10.9	10.9	7.8 (1.5)	0.3	8.0	0.3	2.0 (0.6)	5.0 (1.5)	2.0	4.5	8.5	5.8
	V	11.8	11.8	14.0	14.0	9.9 (1.9)	2.4 (0.5)	10.8	2.6	7.4 (1.8)	9.6 (2.0)	7.0	8.8	11.0	7.5
	VI	15.3	15.3	17.0	17.5	12.5 (2.0)	8.0 (1.9)	12.2	8.0	11.0 (2.4)	12.5 (2.4)	11.1	12.0	13.8	9.5
256	VII	20.0	20.0	21.0	21.0	15.0 (2.5)	13.0 (2.5)	15.5	13.5	15.0 (3.1)	17.0 (2.9)	15.0	16.2	17.0	11.0
	II	0.25	5.1	0.25	5.3	4.4	4.4	4.5	4.5	5.1	0	4.9	0	5.0	3.4
	III	1.5 (0.25)	7.0 (1.7)	1.5	7.3	5.9	5.9	6.0	6.0	0	0.25	0	0.25	6.0	4.0
	IV	4.4 (1.0)	9.9 (2.0)	5.0	10.4	7.1	7.1	7.0	7.0	0.25	2.0 (0.7)	0.25	2.0	8.5	6.0
257	V	8.4 (2.0)	12.8 (2.2)	9.9	13.8	9.0	9.0	9.7	9.7	2.6 (1.0)	6.8 (1.3)	3.0	6.2	11.2	7.8
	VI	12.4 (2.4)	16.5 (3.0)	13.8	17.5	11.8	11.8	12.5	12.5	8.9 (1.8)	10.6 (2.0)	8.1	10.5	14.0	9.5
	VII	17.2 (2.8)	21.0 (3.4)	17.0	22.0	15.0	15.0	15.0	15.0	14.0 (2.8)	15.4 (3.0)	13.0	14.1	17.0	11.3
	II	5.0	5.0	5.1	5.1	0	0.25	0	0.25	5.2	5.2	4.7	4.7	5.0	3.0
258	III	7.0	0	7.0	0	0.25	0.7	0.25	0.7	6.8	6.8	6.0	6.0	6.0	3.9
	IV	9.0 (1.8)	0.25	9.6	0.25	1.4 (0.4)	11.0	1.6	2.2	8.7	8.7	8.3	8.3	8.0	5.5
	V	11.2 (2.3)	2.4	13.0	2.8	0.8	5.0	1.0	5.0	5.8 (1.0)	10.5	11.0	11.0	10.0	6.5

257	VI	15.4 (2.9)	7.6 (2.0)	16.0	9.0	9.0 (2.0)	0.8	8.8	7.8	13.5	13.5	13.8	13.8°	13.0	8.2
	VII	20.5 (3.5)	13.5 (2.6)	21.0	15.4	12.1 (2.3)	1.0	13.0	9.0	17.5	17.5	18.0	18.0	17.0	11.0
	II	5.2	5.2	6.0	6.0	0	5.0	0	4.8	5.8	0.25			5.0	3.1
	III	8.0	8.0	8.5	8.5	0.15	0	0.15	0	7.7 (1.8)	1.8 (0.4)			6.6	4.8
258	IV	11.0	11.0	11.5	11.5	2.0 (0.6)	0.25	2.1	0.25	10.4 (2.3)	5.3 (1.3)			9.5	6.2
	V	15.8	16.0	15.6	15.6	8.0 (1.8)	3.0	7.8	3.1	15.0 (2.6)	11.5 (2.0)			12.0	8.0
	VI	24.0	24.8	22.0	22.0	16.0 (3.0)	12.0	14.4	11.0	20.6 (3.6)	20.0 (3.0)			15.0	10.0
	II	0	5.5	0	5.9	4.8	4.8	4.5	4.5	5.6	0.25	5.0	0.25	5.0	3.1
	III	0.25	7.5	0.25	7.8	6.1	6.1	6.2	6.2	0	1.4 (0.3)	0	1.3	6.5	4.5
259	IV	2.3 (0.7)	11.0 (2.3)	2.6	11.2	8.6	8.6	8.5	8.5	0.25	5.0 (1.5)	0.25	5.0	9.0	6.0
	V	0	15.5	0	15.0	11.5	7.5	11.5	11.5	3.8 (1.0)	9.8 (1.9)	3.2	9.0	12.0	8.2
	VI	0.22	24.0	0.22	22.5	17.2	17.2	16.0	16.0	12.8 (2.1)	16.5 (2.8)	11.3	15.0	14.1	9.9
	III	0.25	8.1	0.25	7.8	6.0	6.0	6.1	6.1	0	1.5 (0.5)	0	1.5	7.0	4.2
	IV	2.0 (0.5)	10.0 (2.3)	2.5	11.0	8.7	8.7	8.7	8.7	0.25	6.0 (1.5)	0.25	5.5	9.0	5.6
260	V	4.5	13.6	8.0	13.8	10.0	10.3	10.0	10.0	2.4 (0.7)	9.6 (1.8)	2.2	9.0	11.5	7.8
	VI	7.5	17.0	13.5	18.0	13.0	13.0	13.0	13.0	9.5 (1.9)	13.5 (2.0)	8.2	12.0	14.8	9.4
	VII	11.8	21.5	19.0	21.5	15.5	15.5	16.0	16.0	14.5 (2.2)	17.2 (2.8)	14.0	15.2	17.0	11.0

261	III	7.4	7.4	7.5	7.5	1.4 (0.5)	0.25	1.5	0.25	0	8.1	0	6.8	6.8	4.0
	IV	10.5	10.5	11.0	11.0	4.7 (1.3)	2.0	4.7	2.0	0.25	10.2 (2.3)	0.25	9.8	9.0	5.9
	V	16.2	16.2	15.5	15.5	9.0 (2.0)	6.7 (1.4)	8.5	6.8	3.0 (0.7)	13.0 (3.0)	3.0	12.2	11.5	7.0
	VI	25.0	27.0	21.5	23.5	14.6 (2.8)	13.0 (2.6)	15.0	12.0	10.9 (2.0)	21.0 (3.2)	10.0	19.0	14.8	10.0
262	III	1.5 (0.5)	7.5	1.9	7.5	0	6.5	0	6.0	8.1	0.25	6.5	0.25	6.5	4.5
	IV	6.0 (1.5)	10.0	6.1	11.5	0.25 (2.3)	9.0 (2.0)	0.25	8.5	10.0 (2.3)	2.5 (0.7)	9.4	2.5	9.5	6.4
	V	10.6 (2.4)	15.7	11.8	15.9	3.0 (0.8)	12.0 (2.5)	3.2	11.0	14.0 (3.0)	9.0 (1.8)	12.0	8.0	12.0	8.0
	VI	18.2 (3.5)	23.0 (4.0)	19.0	21.8	10.0 (2.0)	17.0 (2.7)	10.0	16.0	20.0 (3.5)	16.0 (3.0)	18.6	15.0	15.0	9.4
263	III	7.4	0	8.0	0	7.0	1.5	6.0	1.7	8.5	0.25	6.8	0.25	7.0	4.5
	IV	10.7 (2.3)	0.25	11.8	0.25	8.6 (1.7)	5.4 (1.5)	8.6	5.5	11.0 (2.4)	2.5 (0.6)	9.5	2.3	9.6	6.5
	V	15.5 (3.0)	2.5 (0.6)	15.8	3.8	9.5 (2.0)	11.5 (2.2)	11.5	9.5	15.0 (3.0)	8.5 (2.0)	13.0	8.0	12.6	8.8
	VI	24.0 (4.0)	11.5 (2.1)	22.0	12.0	16.0 (2.9)	16.8 (3.0)	16.0	16.0	22.0 (4.0)	17.0 (3.0)	19.0	16.0	15.5	10.0
264	III	0	8.0	0	8.0	6.2	1.5	6.5	1.7	0.25	7.5	0.25	7.0	7.1	4.6
	IV	0.25	11.0 (2.4)	0.25	11.8	9.0 (2.3)	5.5	9.0	5.5	2.2 (0.6)	10.2 (2.3)	2.2	10.0	9.5	6.1
	V	3.0 (1.0)	15.5 (3.0)	3.0	16.0	12.0 (2.2)	11.0	12.2	10.5	8.0 (2.1)	14.8 (3.0)	7.5	14.0	13.4	8.4
	VI	11.0 (2.0)	24.8 (4.0)	12.0	22.2	18.0	18.0	17.2	17.2	19.0 (3.0)	22.8 (3.2)	17.0	20.0	16.5	10.8

265	III	7.8	0	8.5	0	0.25	6.5	0.25	6.0	7.5	7.5	7.0	7.0	4.5
	IV	10.0	0.12	12.0	0.12	2.1 (0.5)	8.5 (1.7)	2.0	8.5	10.2	10.2	9.0	9.0	6.2
	V	14.0	0	14.6	1.5	6.0 (1.4)	10.4 (2.0)	6.0	11.0	12.6	12.6	12.5	12.5	8.5
	VI	18.5	4.0	18.0	6.0	10.0 (3.0)	13.5 (1.0)	10.2	14.0	16.0	16.0	15.0	15.0	10.6
266	VII	23.0	11.0	22.5	12.0	14.1 (3.6)	16.5 (2.5)	14.8	16.9	19.4	19.0	19.0	19.0	12.8
	III	7.8	7.8	8.2	8.2	7.0	7.0	6.6	6.6	0	0.25	0	0.25	4.5
	IV	11.6	11.6	12.0	12.0	9.7	9.7	9.0	9.0	0.2	2.5 (0.7)	0.2	2.5	6.4
	V	16.0	16.0	16.2	16.2	11.6	11.6	12.0	12.0	2.0 (0.9)	9.2 (2.0)	2.0	8.0	8.5
267	VI	25.5	25.5	23.8	23.8	18.0	18.0	18.0	18.0	9.5 (2.0)	19.2 (3.7)	8.0	17.5	10.0
	III	8.0	8.0	8.2	8.2	6.2	0.25	6.2	0.25	0	7.8	0	7.0	4.0
	IV	10.0	10.0	11.0	11.0	8.0 (1.7)	1.2 (0.5)	8.0	1.5	0.25	9.9 (2.3)	0.25	9.0	5.9
	V	13.5	13.5	15.0	15.0	10.0 (2.0)	5.0 (1.0)	11.0	5.2	1.0	12.8	0.7	12.2	7.4
268	VI	17.0	17.0	18.2	18.2	13.5 (3.0)	8.5 (1.8)	14.0	9.1	4.8 (1.1)	16.0 (3.0)	4.0	15.0	9.5
	VII	22.0	22.0	23.0	23.0	16.6 (3.1)	12.0 (2.2)	17.0	12.0	9.7 (2.0)	20.0 (3.4)	8.8	20.0	12.0
	III	7.2	7.2	7.5	7.5	0.12	6.8	0.12	6.0	7.0	0	6.4	0	4.0
	IV	10.2	10.2	10.5	10.5	1.0 (0.5)	8.2 (1.8)	0.5	8.0	10.0	0	9.0	0	5.6
268	V	13.5	13.5	14.0	14.0					12.9	0.25	11.0	0.25	7.0
	VI	20.2	20.2	20.2	20.2					18.0	2.0	18.0	2.0	9.0

269	III	8.0	8.0	8.5	8.5	6.8	0	6.2	0	7.5	0	7.0	0	7.0	4.2
	IV	10.5	10.5	11.0	11.0	9.0	2.5	8.8	2.1	10.9	0	9.2	0	9.5	6.5
	V	15.5	15.5	15.6	15.6	11.4	8.0	11.5	8.0	14.8	0.25	12.2	0.25	12.4	8.5
	VI	24.0	24.0	22.0	22.0	17.0	15.2	16.0	14.4	22.0	0.18	19.2	0.5	15.5	10.0
270	III	7.5	0.25	8.2	0.25	6.2	6.2	6.7	6.2	0	7.5	0	6.8	6.5	4.2
	IV	10.5	2.2	11.4	3.0	8.3	8.3	8.5	8.5	0	10.0	0	9.5	8.8	6.0
	V	15.0	10.1	15.4	10.1	11.6	11.6	11.5	11.5	0	14.0	0	13.0	12.0	8.0
	VI	24.5	6.0	23.0	19.5	18.0	18.0	17.0	17.0	0	21.0	0	20.0	14.2	10.0
271	III	7.0	7.0	7.5	7.5	0.25	0	0.25	0	2.5	7.0	5.8	6.0	6.1	4.0
	IV	9.8	9.8	10.8	10.8	2.0	0	2.0	0	2.5	9.0	7.5	7.9	8.5	5.8
	V	13.0	13.0	13.8	13.8	6.0	0	6.8	0	4.4	11.2	10.0	10.5	11.4	7.2
	VI	17.0	17.0	18.0	18.0	10.0	0	10.2	0	7.3	15.0	12.0	13.0	15.0	10.0
272	VII	23.0	23.0	23.0	23.0	13.8	0	13.5	0	9.0	19.0	16.0	17.2	19.0	12.5
	III	7.0	7.0	8.5	8.5	6.5	6.5	6.2	6.2	0.25	0	0.25	0	7.0	4.5
	IV	10.0	10.0	11.3	10.9	8.0	8.0	8.4	8.4	2.0	0	2.0	0	9.0	6.4
	V	14.0	13.0	15.0	14.6	10.2	10.2	10.1	10.1	7.0 ^a	0.25	6.7	0.25	12.0	8.3
272	VI	0	17.4	0	18.0	13.0	13.0	14.0	14.0	12.0	2.3	11.5	2.0	15.0	11.0
	VII	0	22.0	0	22.0	15.5	15.5	16.8	16.8	15.5	2.2	15.5	7.0	18.2	13.0

273	III	0	0.25	0	0.25	6.3	6.3	6.0	6.0	7.5	7.5	6.8	6.8	4.3
	IV	0	2.2	0	2.6	8.6	8.6	8.9	8.9	10.5	10.5	9.8	9.8	6.0
	V	0.25	7.5	0.25	8.1	11.0	11.0	11.5	11.5	14.0	14.0	12.6	12.6	8.0
	VI	3.0	15.2	3.2	16.0	14.6	14.6	16.0	16.0	17.5	17.5	18.1	18.1	9.6
274	III	7.1	7.1	7.0	7.0	7.0	0.2	6.5	0.2	0	7.5	0	7.0	4.0
	IV	10.0	10.0	10.5	10.5	8.2	2.0	8.5	2.0	0.2	10.0	0.2	9.2	5.5
	V	13.6	13.6	14.2	14.2	10.0	5.9	11.0	6.0	1.3	12.8	1.2	12.0	7.5
	VI	17.5	17.5	18.4	18.4	13.4	10.0	13.5	10.5	6.6	17.0	5.8	16.0	10.0
275	VII	23.5	23.5	23.6	23.6	16.0	14.0	16.3	14.0	14.9	21.5	12.8	20.0	12.1
	III	0.25	7.9	0.25	7.9	6.4	6.4	6.0	6.0	7.8	0	6.8	0	4.5
	IV	1.7	12.0	2.7	11.5	9.0	9.0	9.0	9.0	11.0	0	10.0	0	6.0
	V	8.6	17.0	9.5	16.0	11.5	11.5	11.8	11.8	15.0	0.6	14.0	0.9	8.1
276	VI	20.0	26.5	19.8	24.0	17.6	17.6	17.0	17.0	23.0	0	21.0	0	10.2
	III	7.0	7.0	7.6	7.6	0	0.25	0	0.2	57.5	7.5	7.0	7.0	4.3
	IV	9.2	9.2	10.2	10.2	0	2.0	0	2.2	9.5	9.5	8.8	8.8	6.0
	V	13.0	13.0	13.1	13.1	0	7.0	0	6.8	12.0	12.0	11.0	11.0	7.8
277	VI	17.0	17.0	17.0	17.0	0	11.0	0	10.9	15.2	15.2	14.5	14.5	10.0
	VII	21.4	21.4	20.8	20.8	0.4	13.1	0.4	14.0	20.0	20.0	18.0	18.0	12.0

277	III	7.5	0.25	8.0	0.25	0	5.8	0	6.5	6.5	6.8	6.8	6.0	4.0
	IV	10.2 (2.3)	2.0 (0.5)	10.9	2.0	0.25	8.0 (1.7)	0.25	8.0	9.9	9.1	9.1	9.0	6.0
	V	13.5	6.4	14.5	7.1	2.0 (0.5)	10.0 (2.0)	2.0	10.0	12.0	11.0	11.0	11.0	7.2
	VI	17.2	12.8	18.0	13.0	5.0 (1.0)	13.0 (2.7)	5.8	13.0	14.0	15.0	15.0	14.0	9.8
	VII	23.0	0	22.2	0	9.0 (2.0)	15.5 (2.3)	9.1	16.0	19.4	17.5	18.0	17.0	12.0
	II	4.9	4.9	5.5	5.5	4.5	4.5	4.2	4.2	0	5.2	2.2	4.5	3.0
	III	7.0	7.0	8.0	8.0	6.2	6.2	6.5	6.5	0	7.8	2.2	6.9	4.4
278	IV	10.1	10.1	11.5	11.5	9.0	9.0	8.0	8.0	0	10.0	2.6	9.0	6.0
	V	13.0	13.0	14.0	14.0	10.5	10.5	10.0	10.0	1.0	12.2	1.5	11.8	7.5
	VI	17.4	17.4	17.0	17.0	13.0	13.0	12.5	12.5	1.8	15.5	4.0	14.5	9.8
	VII	22.0	22.0	21.3	21.0	16.0	16.0	15.5	15.5	5.8	18.5	8.0	17.0	11.6
	II	4.0	4.5	5.4	5.4	4.5	4.5	4.0	4.0	0	5.0	3.0	5.0	2.8
	III	5.0	7.5	7.5	8.0	6.4	6.4	6.0	6.0	0.35	5.0	2.0	6.5	4.8
	IV	0.0	10.4	0.0	10.0	8.0	8.0	8.0	8.0	0	7.4	2.0	8.8	6.0
279	V	1.7	14.0	2.4	13.8	10.5	10.5	10.5	10.5	0	12.0	2.0	13.0	7.5
	VI	9.0 (0.5)	22.5 (2.7)	9.4	20.0	14.9	16.0	15.0	15.0	0	19.0	2.0	17.5	9.0
	II	4.6	4.6	5.6	5.6	4.5	0	4.2	3.0	5.0	4.9	4.9	5.0	3.0
	III	7.5	7.5	8.0	8.0	6.0	0	6.0	2.9	7.5	7.5	6.6	6.5	4.6
	IV	0.0	10.4	0.0	10.0	8.0	8.0	8.0	8.0	0	7.4	2.0	8.8	6.0
	V	1.7	14.0	2.4	13.8	10.5	10.5	10.5	10.5	0	12.0	2.0	13.0	7.5
	VI	9.0 (0.5)	22.5 (2.7)	9.4	20.0	14.9	16.0	15.0	15.0	0	19.0	2.0	17.5	9.0
280	II	4.6	4.6	5.6	5.6	4.5	0	4.2	3.0	5.0	4.9	4.9	5.0	3.0
	III	7.5	7.5	8.0	8.0	6.0	0	6.0	2.9	7.5	7.5	6.6	6.5	4.6
	IV	0.0	10.4	0.0	10.0	8.0	8.0	8.0	8.0	0	7.4	2.0	8.8	6.0
	V	1.7	14.0	2.4	13.8	10.5	10.5	10.5	10.5	0	12.0	2.0	13.0	7.5
	VI	9.0 (0.5)	22.5 (2.7)	9.4	20.0	14.9	16.0	15.0	15.0	0	19.0	2.0	17.5	9.0
	II	4.6	4.6	5.6	5.6	4.5	0	4.2	3.0	5.0	4.9	4.9	5.0	3.0
	III	7.5	7.5	8.0	8.0	6.0	0	6.0	2.9	7.5	7.5	6.6	6.5	4.6

280	IV	10.5	10.5	11.0	11.0	8.0	8.0	1.8	10.0	10.0	9.0	9.0	6.4
	V	14.0	14.0	14.0	10.0	1.2	10.4	3.8	13.0	13.0	12.0	12.0	8.0
	VI	19.0	19.0	19.0	14.0	0	14.0	8.5	18.0	18.0	16.0	16.0	10.5
	VII	24.5	24.5	24.0	16.6	3.3	17.0	10.2	22.0	22.0	21.9	21.9	13.0
281	II	5.0	5.0	5.6	5.6	4.6	4.6	4.5	0	5.4	2.8	5.0	3.0
	III	7.6	7.6	8.4	8.4	6.4	6.4	6.0	0	7.9	2.5	7.0	4.0
	IV	11.0	11.0	11.5	11.5	9.0	9.0	8.0	0.45	10.0	2.6	9.0	6.0
	V	15.0	15.0	15.5	15.5	11.0	11.0	10.6	0	14.0	3.0	12.5	8.2
	VI	23.0	23.5	22.0	22.0	16.2	16.2	15.0	0	20.1	3.0	17.6	10.0
	I	3.4	0	3.6	2.7	3.0	3.0	3.0	3.4	3.4	3.0	3.0	2.4
282	II	4.8	0	5.2	2.0	4.0	4.0	4.1	5.0	5.0	4.8	4.6	2.9
	III	8.0	0.4	8.5	1.2	6.5	6.5	6.3	8.1	8.1	7.0	7.0	4.2
	IV	11.0	2.0	11.5	2.6	8.8	8.8	9.0	10.5	10.5	9.5	9.0	6.0
	V	(2.4)	(0.5)	15.0	7.0	10.6	10.6	11.5	14.0	14.0	14.8	11.0	7.5
	VI	(3.0)	(1.4)	21.5	20.0	15.8	15.8	15.8	19.0	19.0	16.4	15.5	10.0
	I	(4.0)	(3.5)	20.0	18.5	15.8	15.8	15.8	19.0	19.0	16.4	16.4	10.0
283	I	3.4	0	3.8	2.8	3.1	3.1	3.0	4.0	4.0	3.2	3.4	2.7
	II	5.4	0	6.0	1.9	4.5	4.5	4.8	5.8	5.8	5.1	5.0	3.0
	III	7.0	1.5	7.5	1.5	6.0	6.0	6.0	7.0	7.0	6.5	7.2	4.3

283	IV	10.0 (2.6)	5.0 (1.7)	10.5	6.6	8.0	8.0	7.8	7.8	9.5	9.5	8.2	8.2	9.0	6.0
	V	15.2 (2.7)	7.0 (1.7)	15.2	7.0	12.0	12.0	12.0	12.0	14.5	14.5	13.2	13.2	11.5	8.0
	VI	21.0 (4.0)	14.1 (3.0)	19.8	13.0	15.0	15.0	16.0	16.0	20.0	0	18.0	0	13.5	9.0
284	I	0	3.5	2.0	3.7	3.0	3.0	3.0	3.0	3.5	3.5	3.2	3.2	3.1	2.1
	II	0	4.5	1.8	5.8	4.4	4.4	4.2	4.2	5.0	5.0	4.5	4.5	4.5	3.0
	III	0.2	7.0	1.5	7.0	6.0	6.0	6.0	6.0	6.5	6.5	6.5	6.5	6.0	4.0
	IV	2.0 (0.6)	9.5 (2.0)	2.4	9.9	7.2	7.2	7.8	7.8	9.0	9.0	9.0	9.0	8.0	5.5
	V	6.6 (1.2)	13.6 (3.0)	6.0	14.0	10.0	10.0	10.0	10.0	11.6	11.6	11.5	11.5	11.2	7.0
	VI	14.0 (3.0)	20.0 (4.0)	11.0	19.0	14.0	14.0	14.0	14.0	17.0	17.0	16.5	16.5	14.0	9.0
	I	0	3.2	2.0	3.6	3.0	3.0	3.0	3.0	4.0	4.0	3.7	3.7	3.2	2.0
285	II	0	5.0	0.25	5.6	4.1	4.1	4.2	4.2	5.3	5.3	5.0	5.0	4.5	3.0
	III	0	7.0	1.0	7.1	6.0	6.0	6.0	6.0	6.6	6.6	6.0	6.0	6.0	4.0
	IV	0	9.2	1.0	10.0	7.5	7.5	7.2	7.2	8.5	8.5	8.0	8.0	8.8	5.9
	V	0.4	12.5	1.5	12.6	9.6	9.6	10.0	10.0	10.5	10.5	10.5	10.5	11.0	7.5
	VI	2.0 (0.6)	16.0 (3.0)	4.7	16.8	12.0	12.0	11.8	11.8	14.2	14.2	13.6	13.6	14.0	9.8
	VII	7.0 (1.3)	21.0 (3.0)	10.0	20.0	14.0	14.0	15.0	15.0	18.5	18.5	17.0	17.0	16.5	11.2
	I	3.6	3.6	4.0	4.0	3.2	3.2	3.1	3.1	4.1	0	3.9	1.5	3.1	2.0
286	II	5.0	5.0	5.8	5.8	4.2	4.2	4.2	4.2	5.2	0	4.5	0.8	5.0	3.1

286	III	7.0	7.0	7.8	7.8	6.0	6.0	5.5	5.5	7.0	0.25	6.0	0.55	6.5	4.2
	IV	10.0	10.0	10.4	10.4	8.0	8.0	8.0	8.0	9.4	0.25	8.7	0.7	8.5	5.8
	V	14.0	14.0	14.0	14.0	10.0	10.0	10.0	10.0	12.0	0	13.0	0.5	11.8	7.2
	VI	21.0	21.0	19.0	19.0	15.0	15.0	14.5	14.5	19.0	0.2	18.0	0.5	14.9	9.0
	I	3.1	3.1	3.2	3.2	3.0	0	3.2	1.8	4.0	4.0	3.6*	3.6	3.1	2.2
	II	4.6	4.6	5.0	5.0	4.5	0	4.4	0.7	5.0	5.0	5.0	5.0	4.2	2.8
287	III	6.0	6.0	6.7	6.7	5.0	0.4	5.0	1.0	6.2	6.2	5.7	5.7	5.5	3.4
	IV	8.0	8.0	8.5	8.5	(1.4)	(0.1)	6.7	2.0	8.0	8.0	8.0	8.0	7.8	5.0
	V	11.0	11.0	12.0	12.0	(1.5)	(0.5)	8.0	6.0	10.5	10.5	10.0	10.0	10.0	7.0
	VI	14.2	14.2	14.5	14.5	(2.0)	(1.1)	10.6	9.0	12.5	0	12.5	0	13.5	9.0
	I	3.3	3.3	4.0	4.0	3.0	3.0	2.9	2.9	0	3.8	1.4	3.5	3.5	2.2
	II	5.0	5.0	5.1	5.1	4.6	4.6	4.5	4.5	0	5.0	0.7	5.0	5.0	3.0
288	III	7.0	7.0	8.0	8.0	6.2	6.2	6.0	6.0	0.25	7.0	0.5	6.2	6.5	4.0
	IV	10.0	10.0	10.0	10.0	8.0	8.0	8.0	8.0	0.5	9.6	2.0	9.0	9.0	5.5
	V	13.0	13.0	14.0	14.0	10.1	10.1	10.1	10.1	(0.3)	(2.2)		11.1	11.2	7.4
	VI	16.3	16.3	17.0	17.0	12.6	12.6	13.0	13.0	(0.7)	(2.7)	8.0	14.0	14.0	9.0
	VII	21.0	21.0	21.5	21.5	16.5	16.5	16.2	16.2	(1.0)	(3.0)	18.0	18.8	18.0	12.0
	I	3.3	3.3	4.0	4.0	3.0	3.0	2.9	2.9	(2.0)	(3.3)				
	II	5.0	5.0	5.1	5.1	4.6	4.6	4.5	4.5						

293	I	0	4.0	2.6	4.1	3.6	3.6	3.3	3.3	4.4	4.4	4.0	4.0	3.4	2.1
	II	0	5.1	2.0	5.5	4.2	4.2	4.5	4.5	5.1	5.1	4.7	4.7	4.6	3.0
	III	0.18	7.0	1.6	8.0	6.0	6.0	6.2	6.2	7.1	7.1	6.8	6.8	7.0	4.2
	IV	0.5	10.0	1.7	10.1	7.8	7.8	8.0	8.0	9.0	9.0	8.5	8.5	9.2	6.0
	V	0.7 (0.5)	13.2 (2.5)	4.0	13.4	9.5	9.5	10.5	10.5	12.0	12.0	11.0	11.0	11.0	7.5
	VI	1.8 (1.4)	16.0 (3.0)	7.5	16.4	12.0	12.0	13.0	13.0	13.6	13.6	13.2	13.2	14.0	9.4
294	I	3.0	3.0	3.5	3.5	3.0	3.0	3.0	3.0	3.7	0	3.1	2.2	3.0	2.0
	II	5.1	5.1	5.1	5.1	2.5	4.0	3.5	3.5	4.6	0	4.2	1.8	4.4	2.8
	III														
	IV	9.0	8.5	9.1	9.1	5.0	7.0	7.0	7.0	8.2 (2.0)	2.0 (0.7)	7.6	2.5	8.5	5.5
	V	12.0	12.0	11.5	11.5	8.0	9.5	9.0	9.0	11.0 (2.0)	5.0 (1.4)	10.4	5.5	10.6	7.0
	VI	15.5	15.5	15.0	15.0	11.5	11.5	12.0	12.0	14.0 (2.8)	8.8 (1.3)	13.8	7.8	13.6	9.0
	VII	20.0	20.0	18.7	18.7	14.5	14.5	15.6	15.6	15.6 (3.0)	12.0 (1.8)	16.5	10.5	16.0	11.0
	I	3.0	3.0	3.3	3.3	3.0	3.0	2.8	2.8	0	3.6	2.6	3.2	3.0	2.0
	II	5.0	5.0	5.0	5.0	4.2	4.2	4.0	4.0	0	5.5	2.2	4.8	4.2	3.0
	III	7.0	7.0	7.2	7.2	6.0	6.0	5.5	5.5	0	7.0	2.5	7.0	6.0	4.0
295	I	3.5	3.5	3.6	3.6	0	3.4	1.4	3.2	3.8	3.8	3.5	3.5	3.1	2.0
	II	4.7	4.7	5.4	5.4	0	4.2	0.9	4.0	5.0	5.0	4.5	4.5	5.0	3.1
296	I	3.5	3.5	3.6	3.6	0	3.4	1.4	3.2	3.8	3.8	3.5	3.5	3.1	2.0
	II	4.7	4.7	5.4	5.4	0	4.2	0.9	4.0	5.0	5.0	4.5	4.5	5.0	3.1

299	III	6.8	1.0	7.0	1.8	6.4	6.4	5.8	5.8	0	0	0	0	6.5	4.4
	IV	10.0	0.8	10.0	4.0	8.8	8.8	8.0	8.0	0.4	0.25	0.4	0.25	8.6	6.0
	V	12.5	2.5	13.5	6.2	10.0	10.0	10.2	10.2	0.5	3.0	2.9	3.0	11.2	7.6
	VI	16.0	6.0	18.0	10.0	13.8	12.8	13.0	13.0	1.0	9.0	6.0	9.0	14.0	10.0
	VII	21.0	10.5	22.0	13.5	17.5	17.5	17.0	17.0	1.2	15.0	9.5	15.0	17.0	12.0
	I	3.2	3.2	3.5	3.5	3.2	0	3.0	2.0	3.6	3.6	3.6	3.6	3.1	2.0
	II	4.4	4.4	5.5	5.5	4.0	0	4.0	2.0	5.1	5.1	4.2	4.2	4.6	3.0
300	III	0	6.5	0	7.0	5.8	0.5	5.0	1.25	6.5	6.5	5.5	5.5	6.2	4.2
	IV	1.3	9.0	1.8	9.2	7.0	2.0	7.2	2.0	8.0	8.0	7.8	7.8	8.5	5.8
	V	5.0 (1.0)	11.8 (2.0)	6.4	12.2	8.5 (1.25)	6.0 (0.5)	10.0	5.5	10.2	10.2	10.5	10.5	10.8	7.5
	VI	0	14.8	0	15.9	10.9 (2.0)	9.2 (1.2)	12.0	8.0	12.9	12.9	12.0	12.0	13.8	9.0
	VII	0	18.0	0	19.8	13.0 (1.9)	13.0 (1.3)	14.8	10.0	16.0	16.0	16.0	16.0	17.0	11.5
	I	3.1	3.1	3.2	3.2	3.0	0	3.0	1.8	3.5	3.5	3.4	3.4	3.5	2.2
	II	5.0	5.0	5.2	5.2	4.0	0	4.0	1.0	5.0	5.0	4.5	4.5	5.0	3.0
301	III	6.0	6.0	7.0	7.0	5.9	0	5.5	1.5	6.7	6.7	6.0	6.0	6.0	4.0
	IV	9.0	9.0	10.0	10.0	7.5 (1.5)	0.7 (0.2)	7.5	3.0	9.0	9.0	8.0	8.0	8.6	5.6
	V	11.8	11.8	12.9	12.9	9.4 (2.0)	1.3 (0.7)	10.0	5.8	11.0	11.0	10.0	10.0	11.0	7.0
	VI	15.0	15.0	16.0	16.0	11.5 (2.2)	2.0 (0.7)	11.6	8.8	13.0	13.0	13.0	13.0	14.0	8.5

Measurements in brackets show the lengths of the regenerate metatarsi.

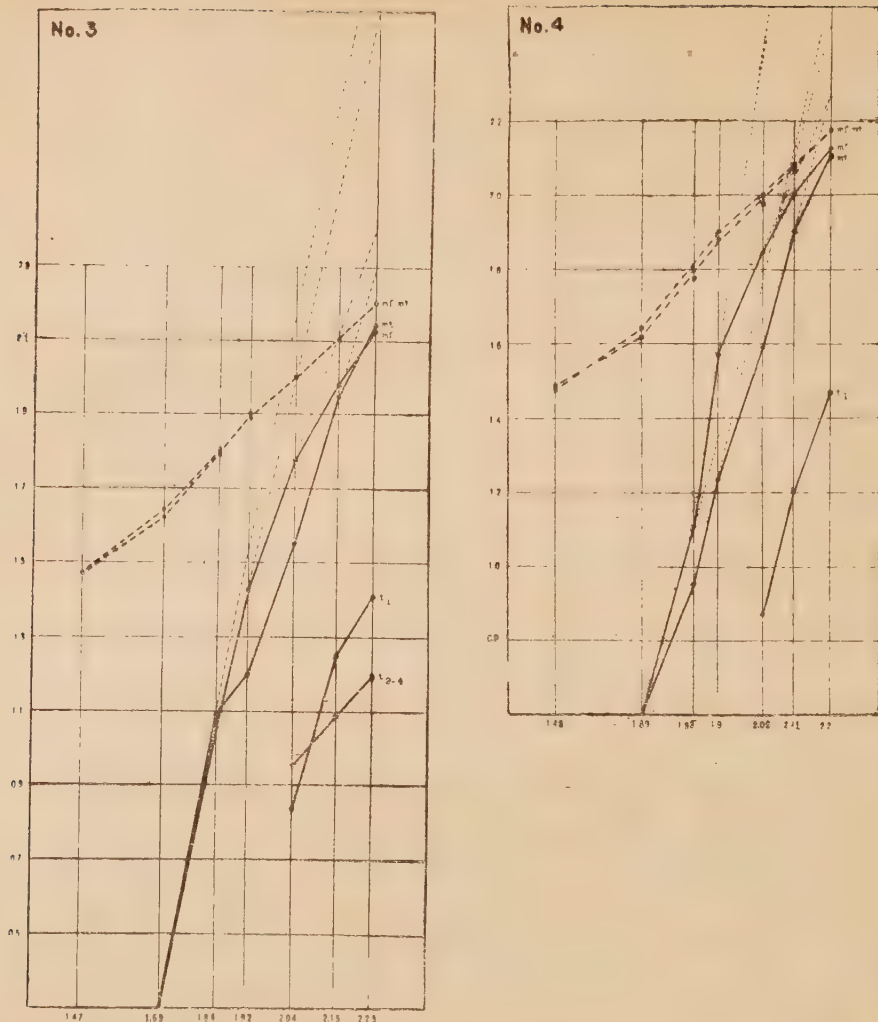
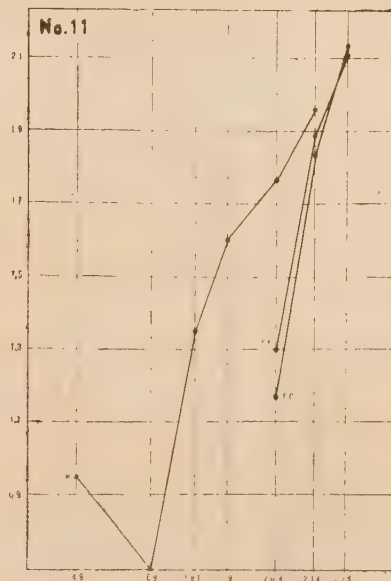
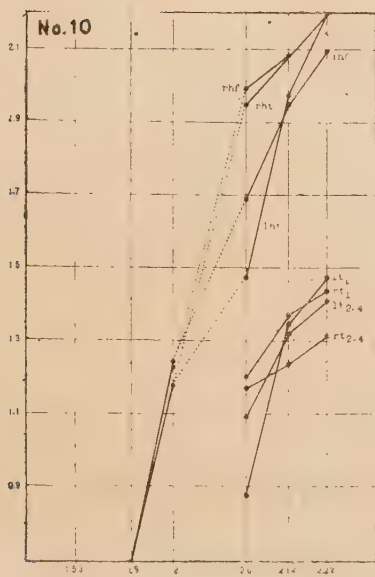
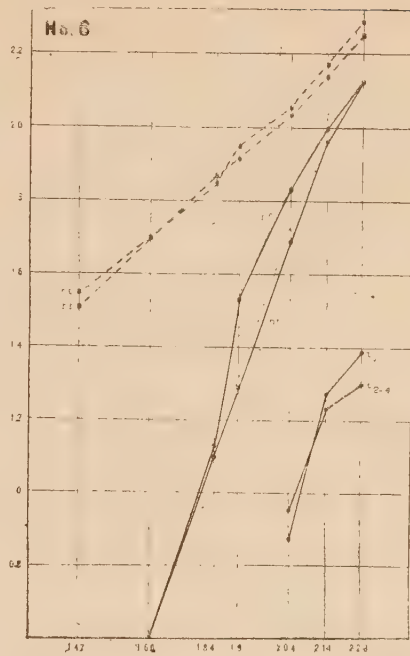
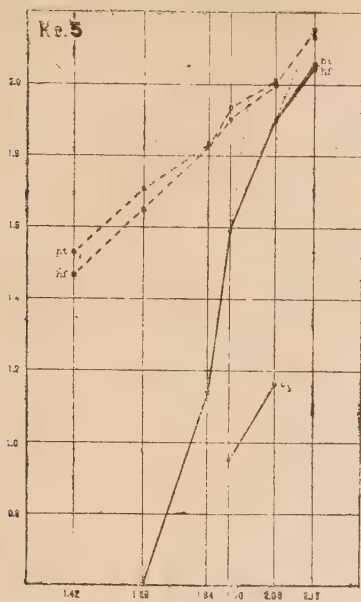
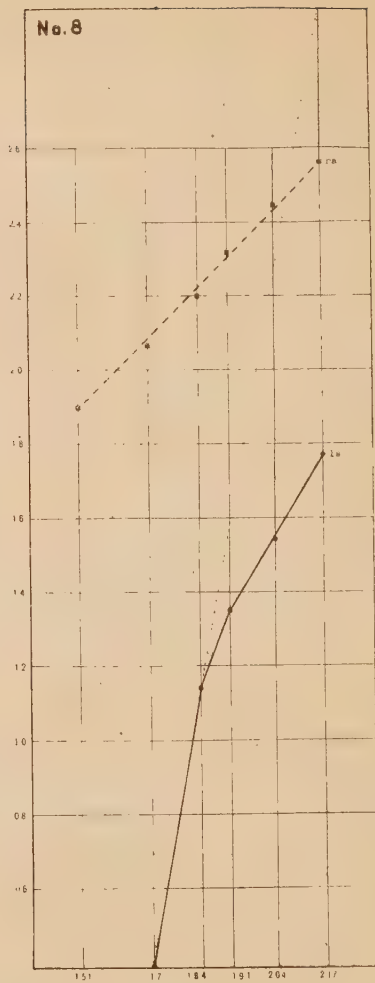
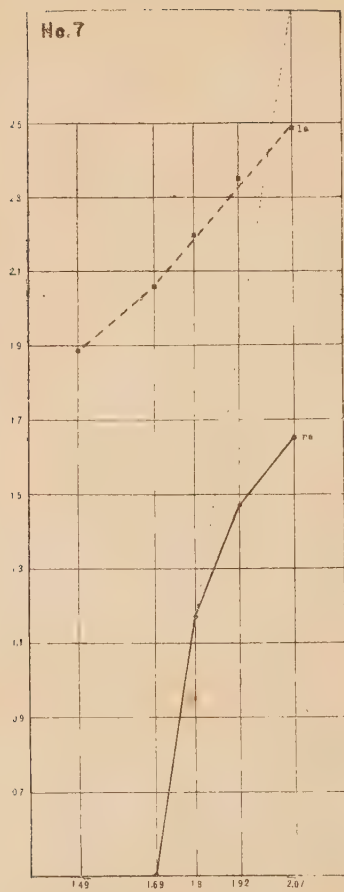
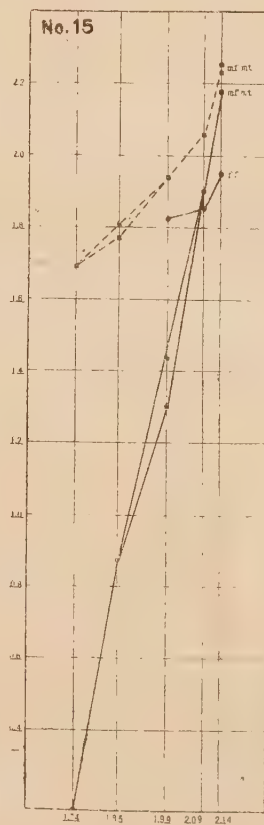
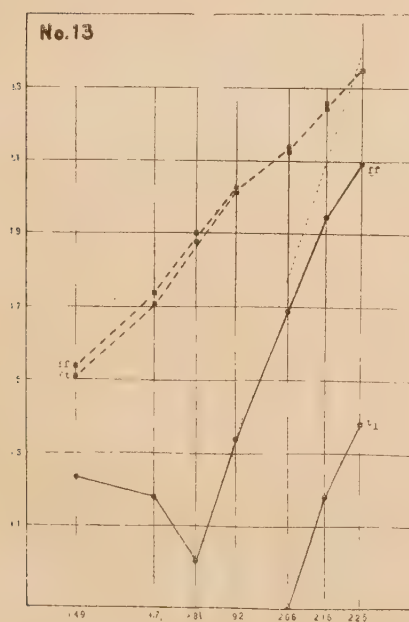
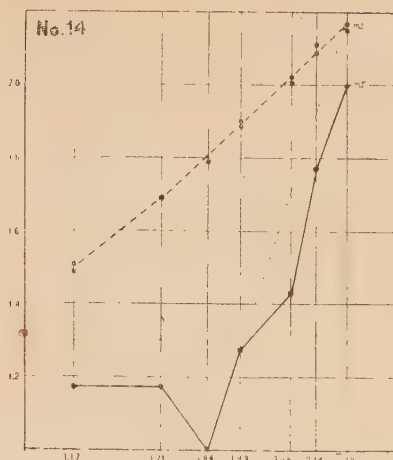
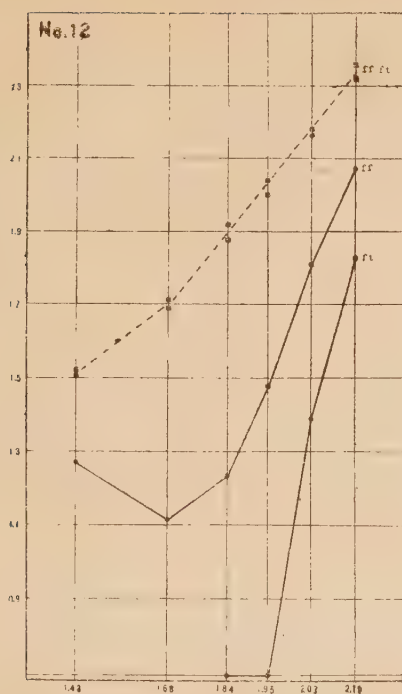
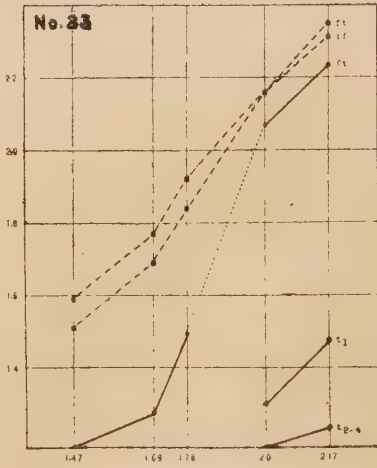
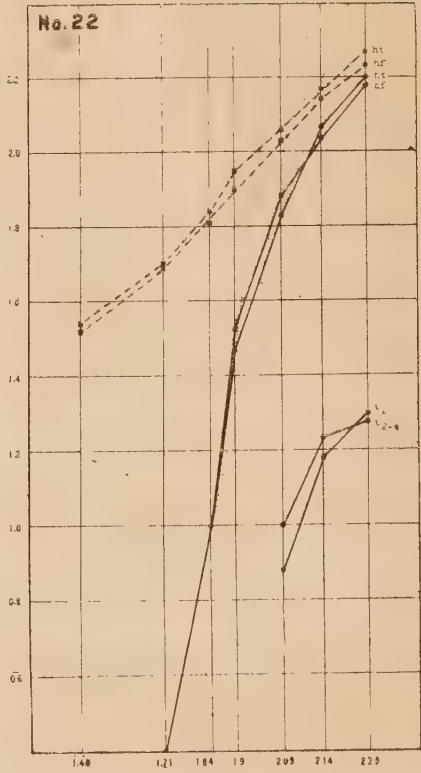
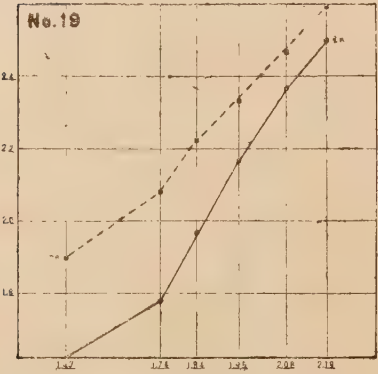
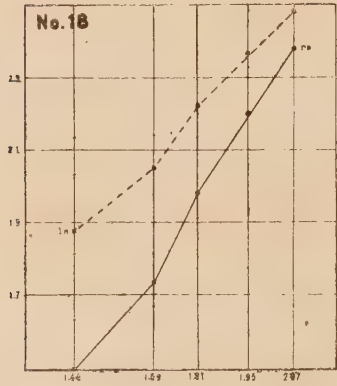
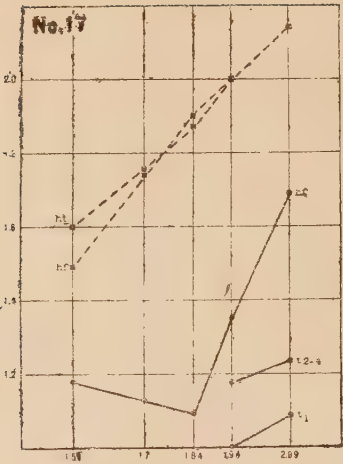


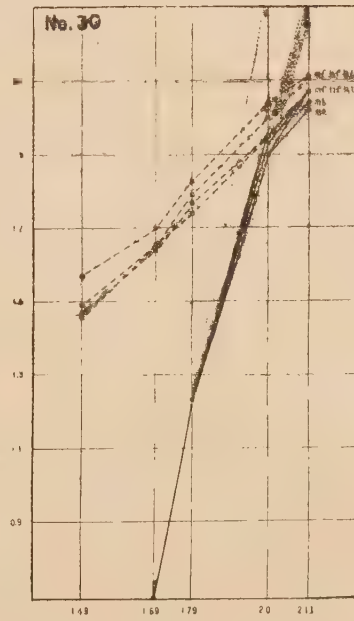
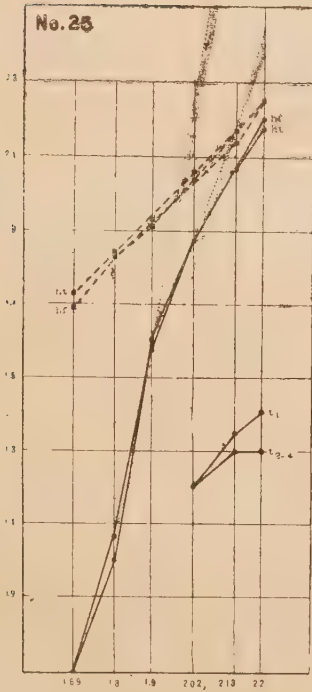
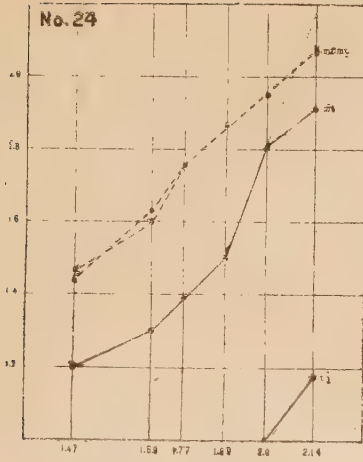
Fig. 3. Regeneration curves of *Phraortes kumamotoensis* Shiraki. Full line: growth curve of a regenerate. Broken line: growth curve of a normal appendage. a: antenna. la: left-hand antenna. ra: right-hand antenna. fl: fore leg. ff: fore femur. lff: left-hand fore femur. rff: right-hand fore femur. ft: fore tibia. lft: left-hand fore tibia. ml: mid-leg. mf: mid-femur. lmf: left-hand mid-femur. rmf: right-hand mid-femur. mt: mid-tibia. lmt: left-hand mid-tibia. rmt: right-hand mid-tibia. hf: hind femur. lhf: left-hand hind femur. rhf: right-hand hind femur. ht: hind tibia. lht: left-hand hind tibia. rht: right-hand hind tibia. t: tarsus. t_1 : basitarsus. lt_1 : left-hand basitarsus. rt_1 : right-hand basitarsus. t_{2-4} : apical tarsal segments (2+3+4). lt_{2-4} : left-hand apical tarsal segments. rt_{2-4} : right-hand apical tarsal segments. ft_1 : fore basitarsus. lft_1 : left-hand fore basitarsus. rft_1 : right-hand fore basitarsus. ft_{2-4} : apical tarsal segments of fore leg. mt: mid-basitarsus. lmt_1 : left-hand mid-basitarsus. rmt_1 : right-hand mid-basitarsus. mt_{2-4} : apical tarsal segments of mid-leg. ht_1 : hind basitarsus. ht_{2-4} : apical tarsal segments of hind leg. lht_1 : left-hand hind basitarsus. rht_1 : right-hand hind basitarsus. lht_{2-4} : left-hand apical tarsal segments of hind leg.

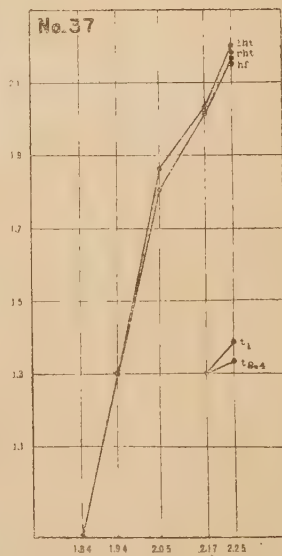
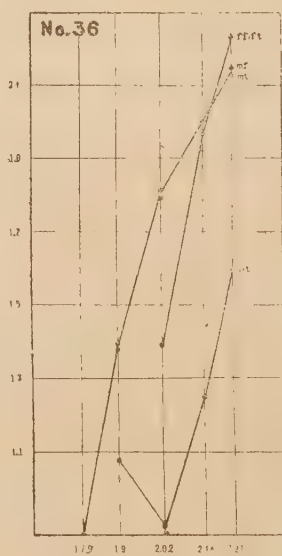
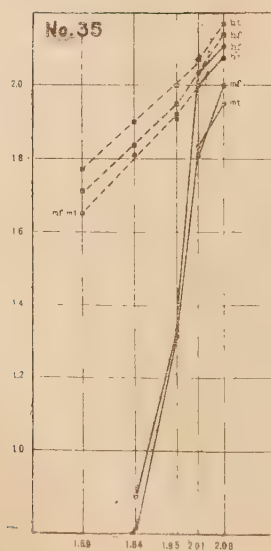
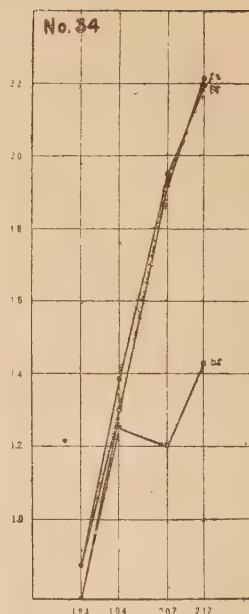
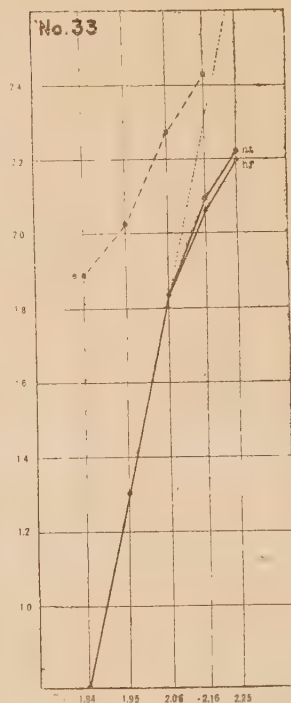
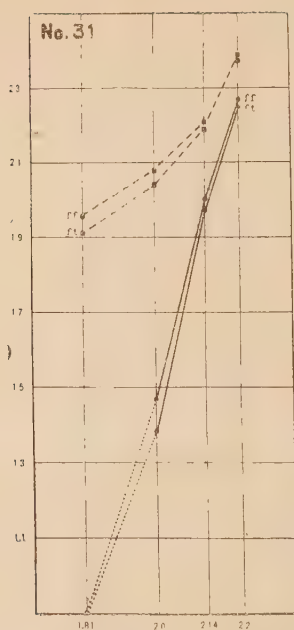


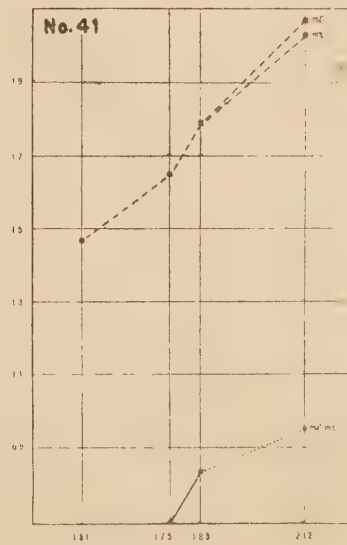
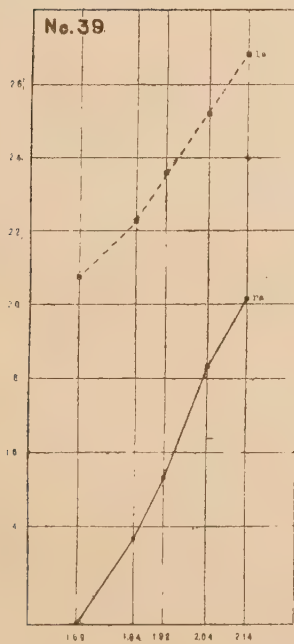
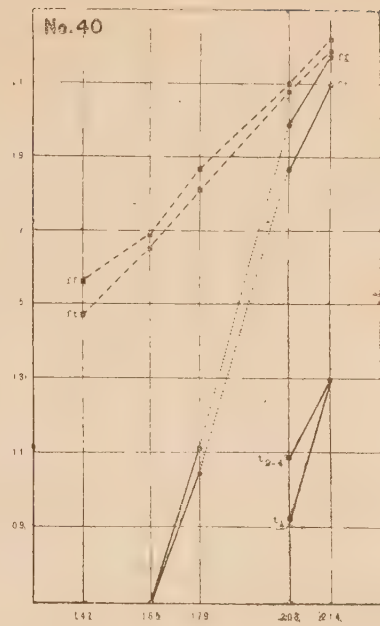
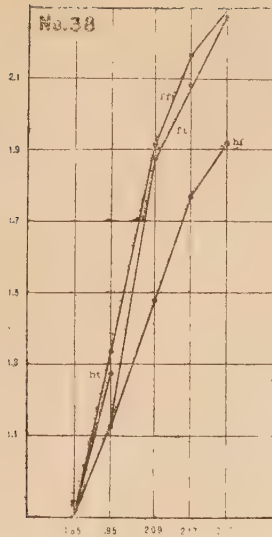


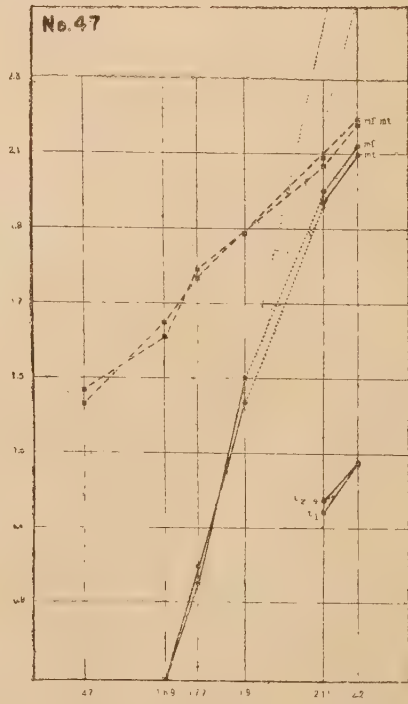
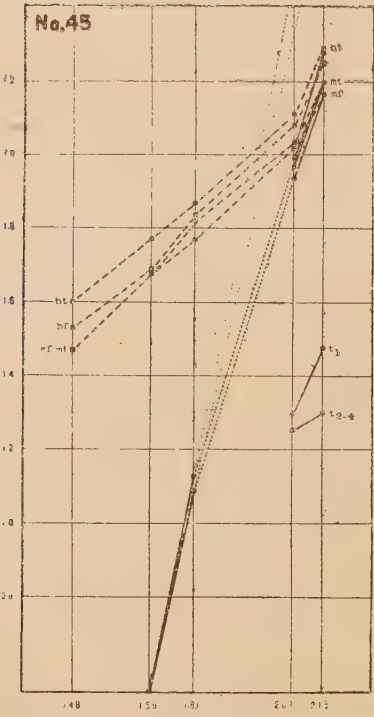
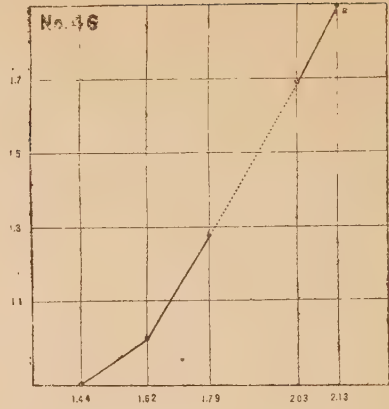
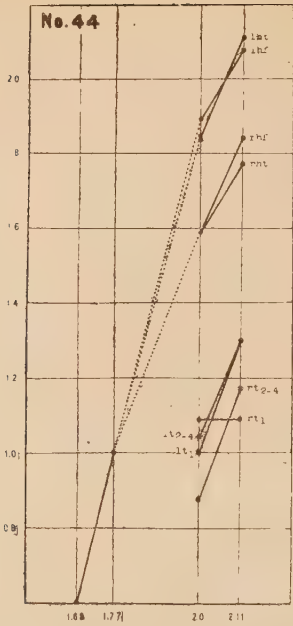


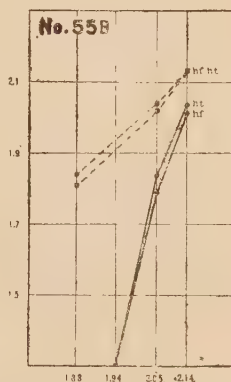
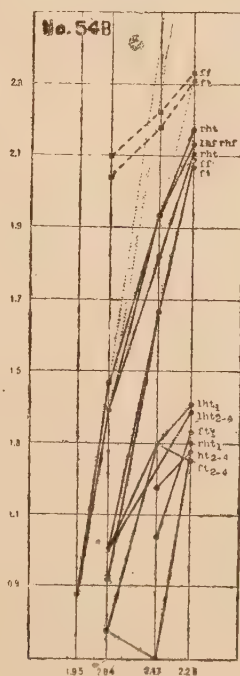
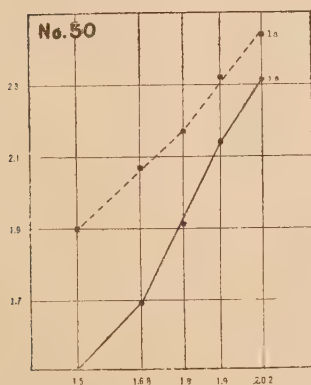
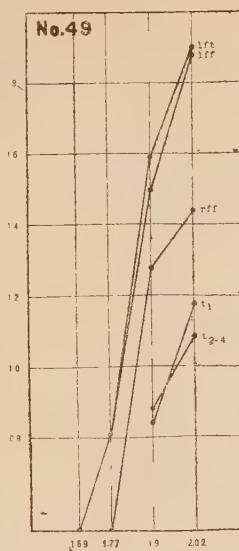
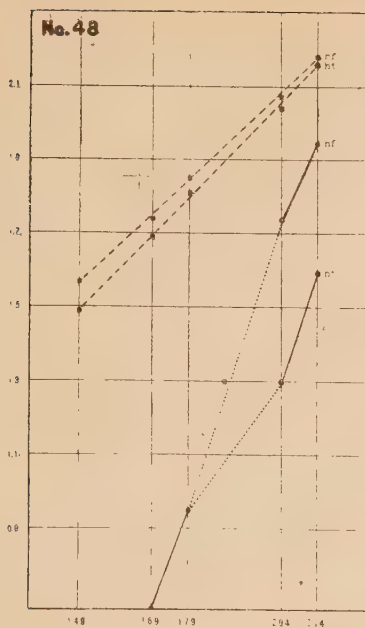


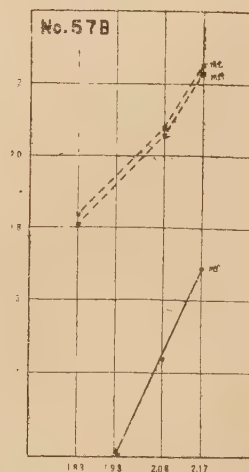
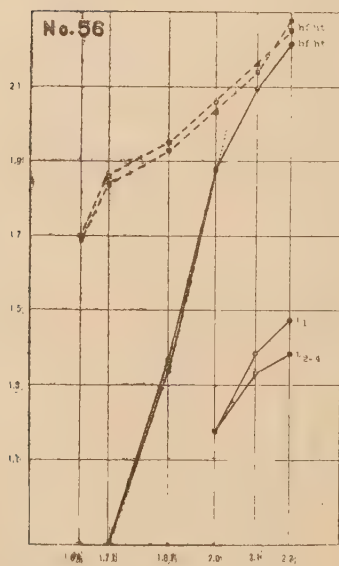
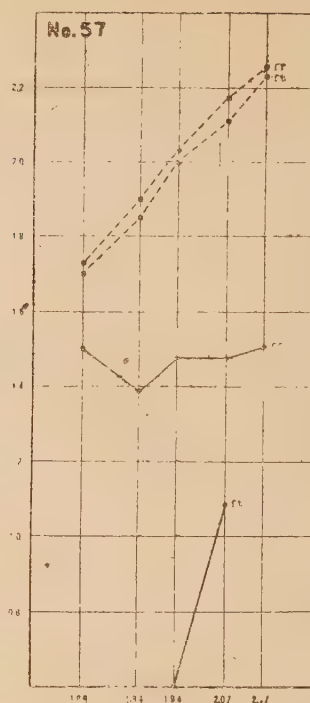
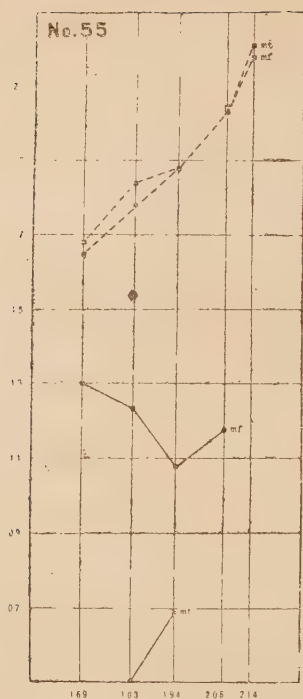


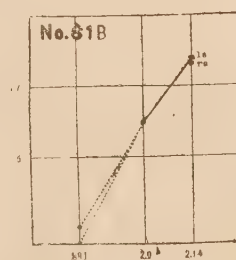
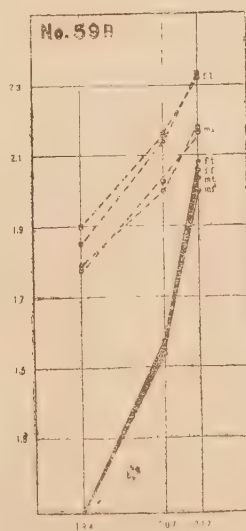
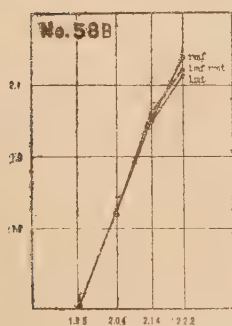
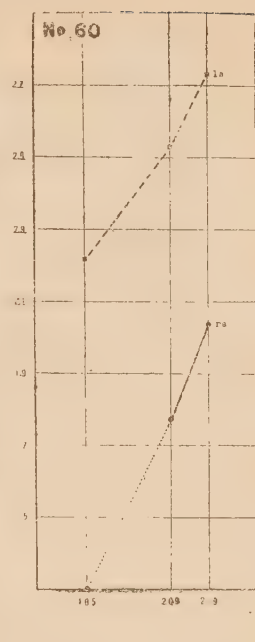
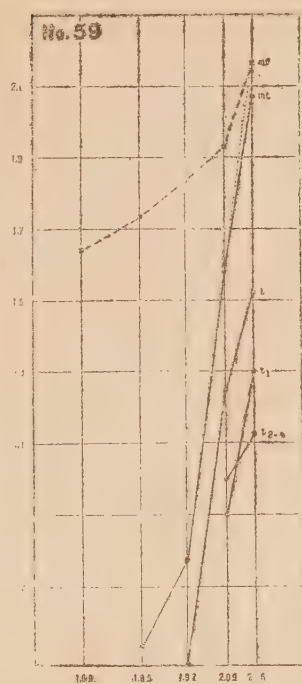
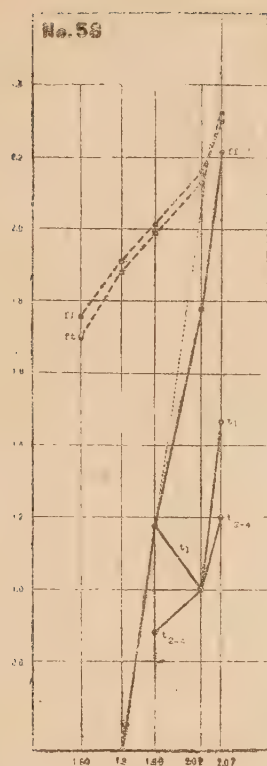


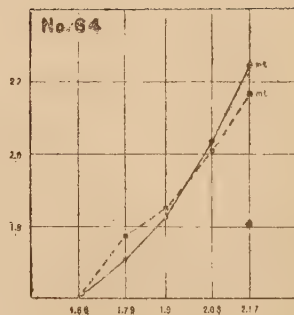
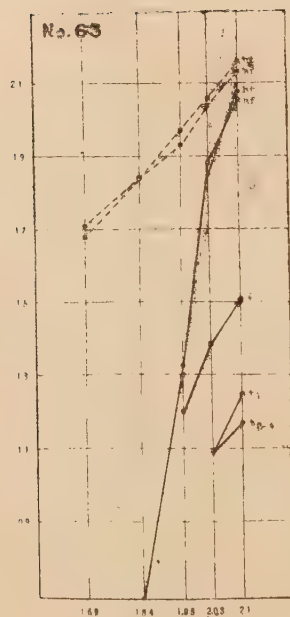
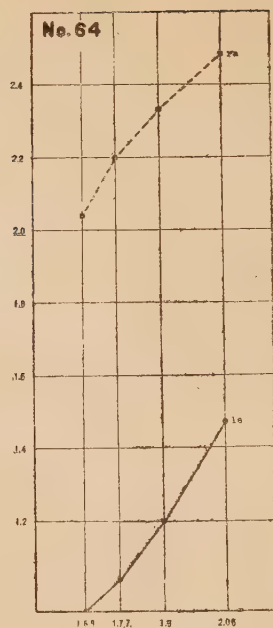
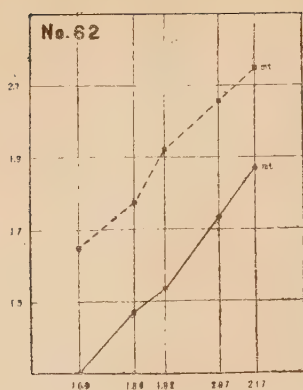


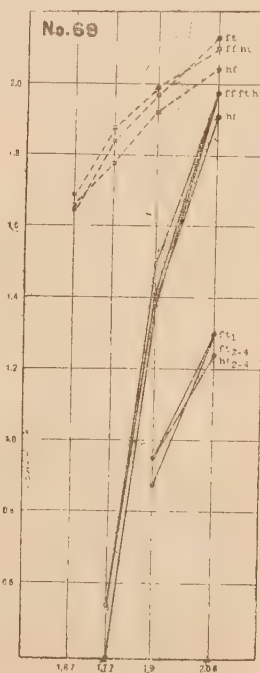
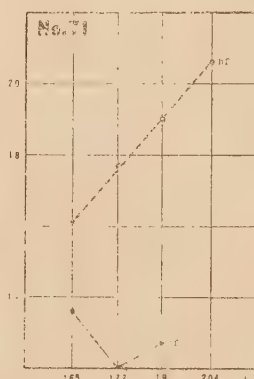
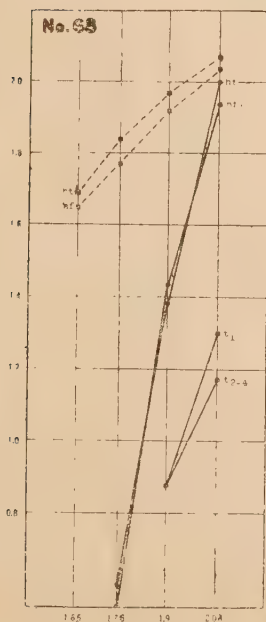
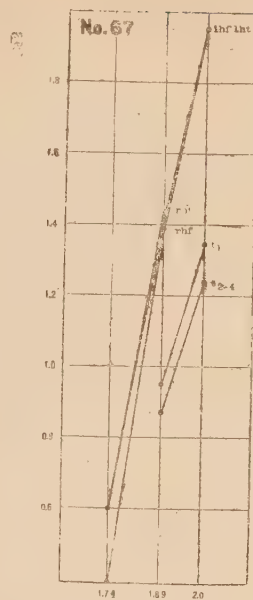
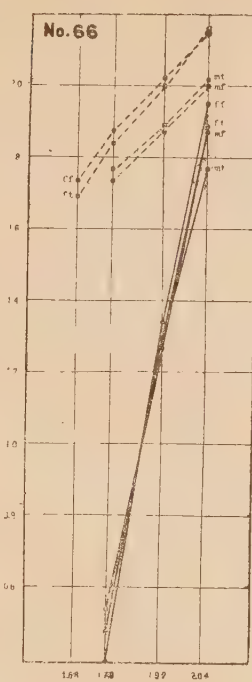
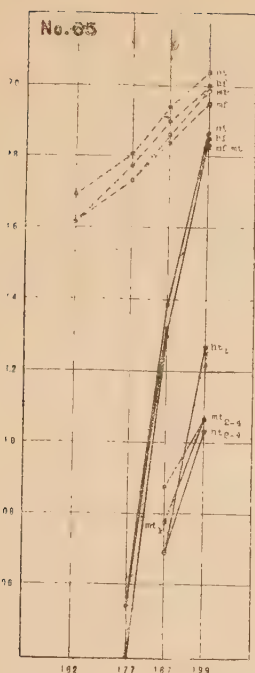


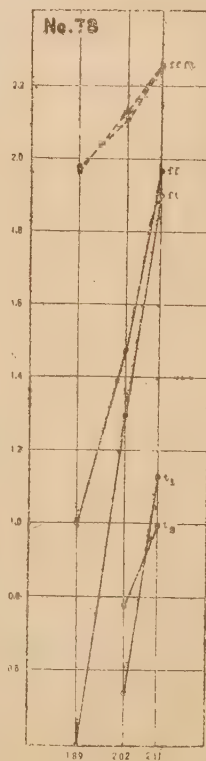
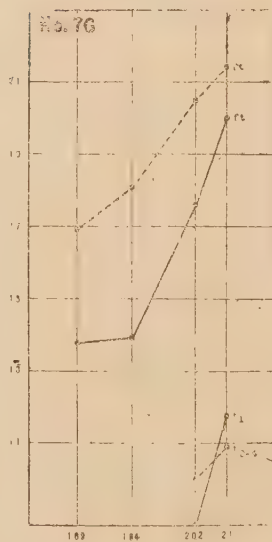
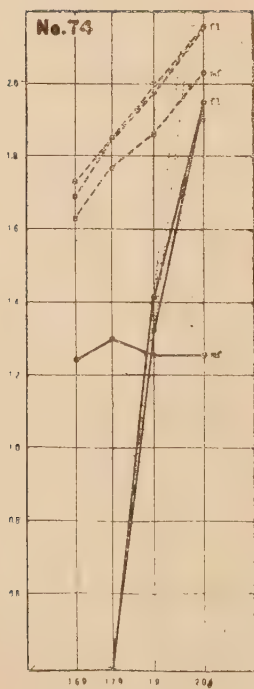
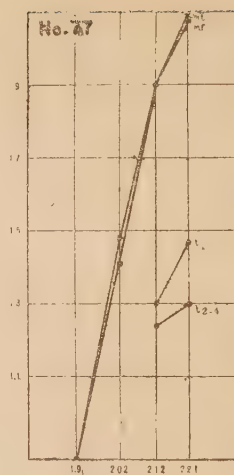
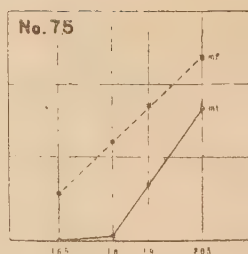


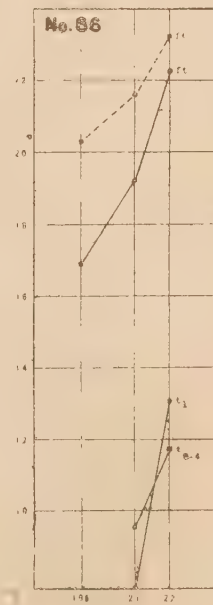
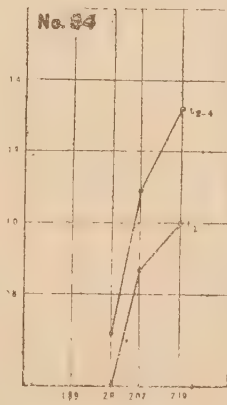
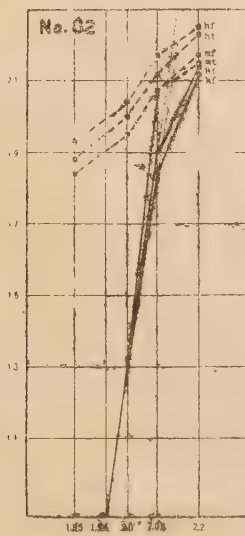
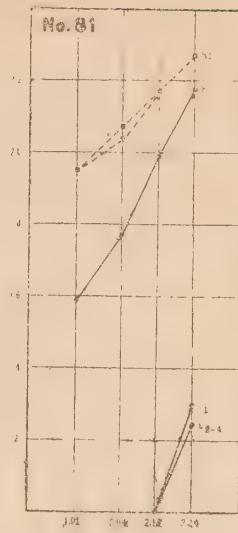
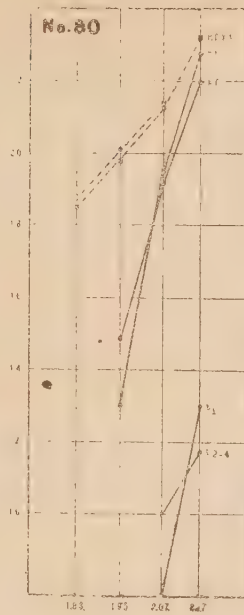
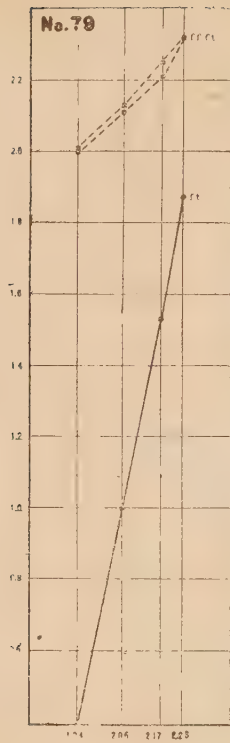


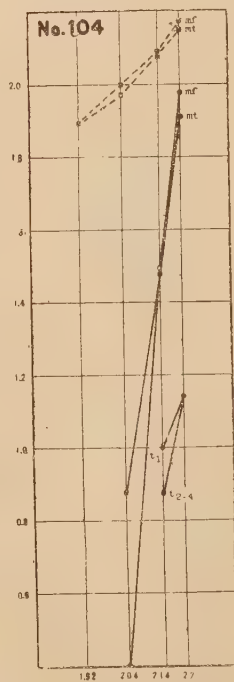
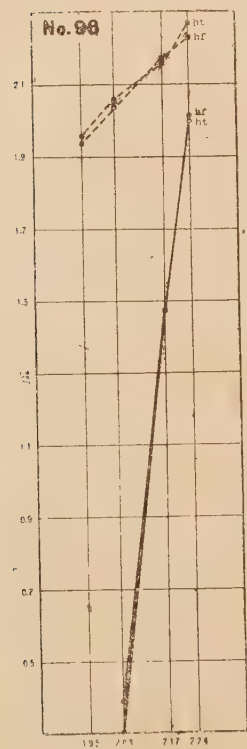
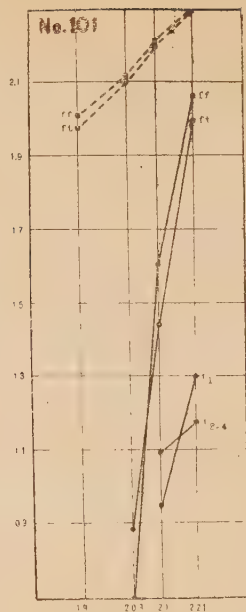
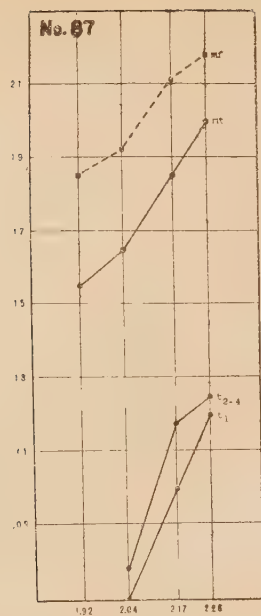


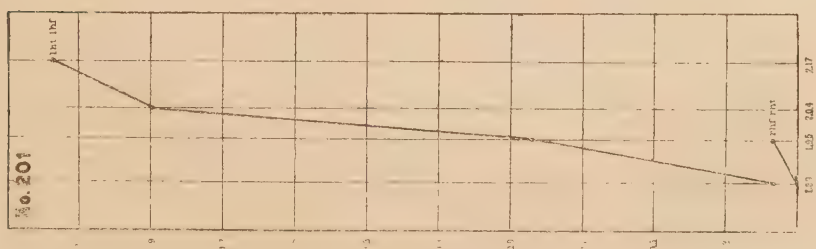
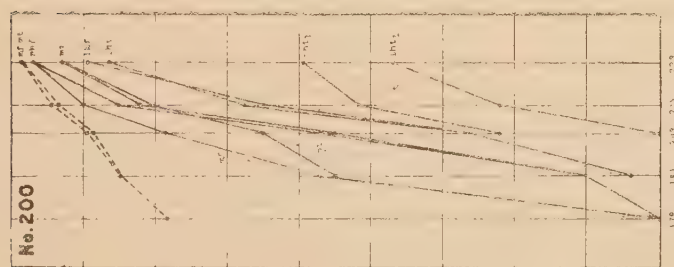
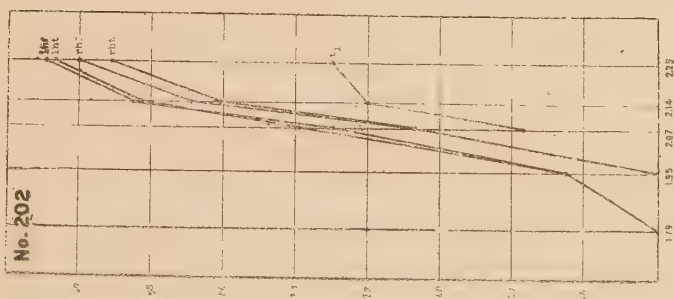
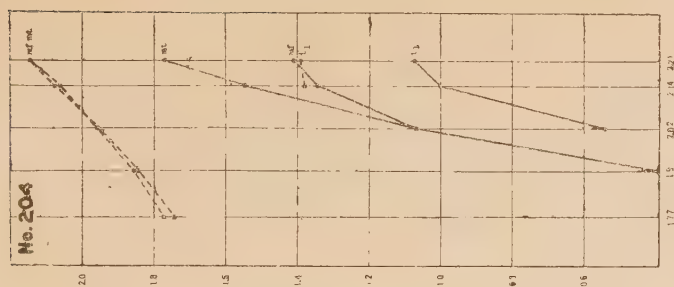


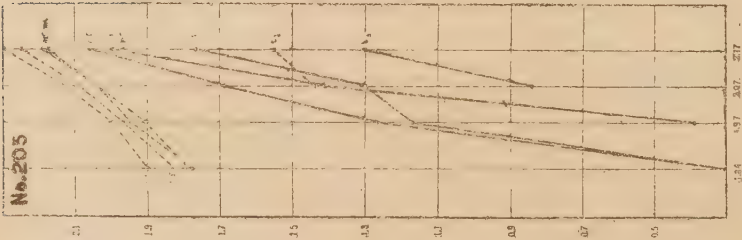
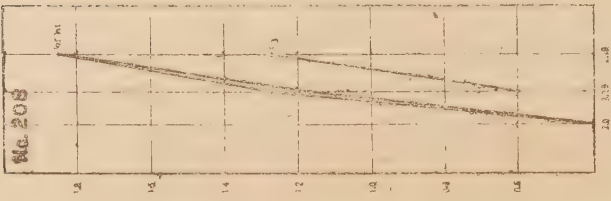
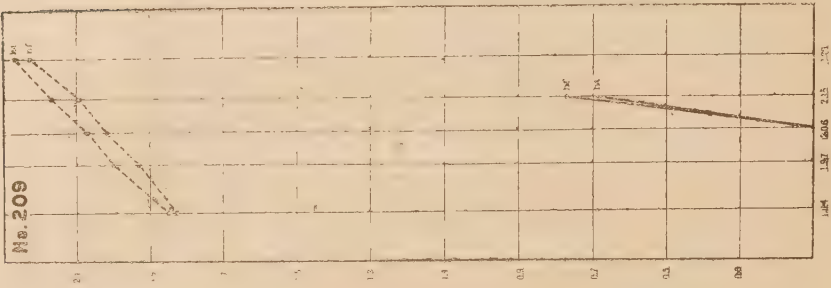
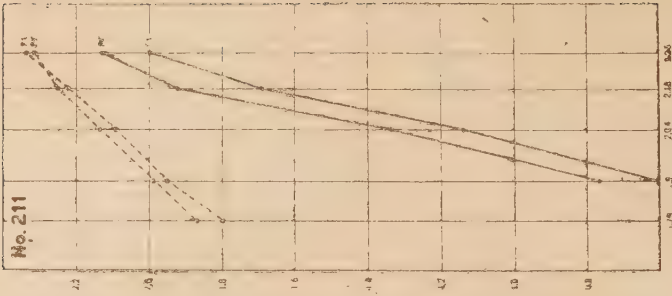


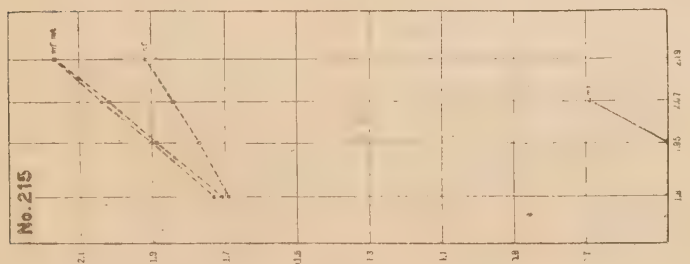
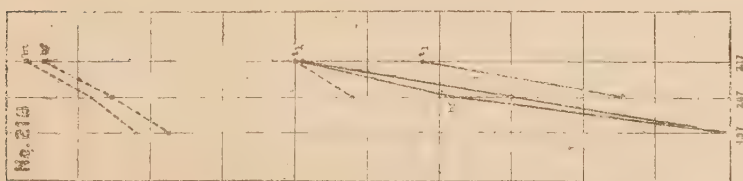
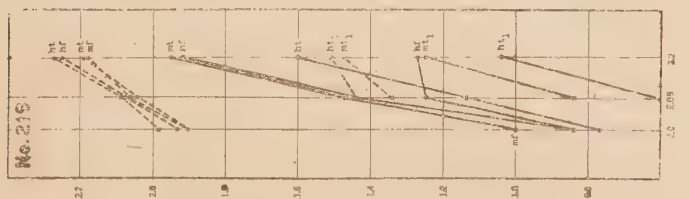
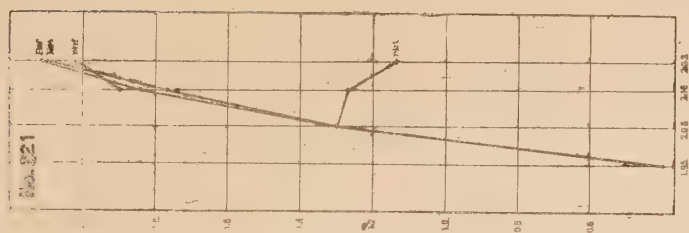


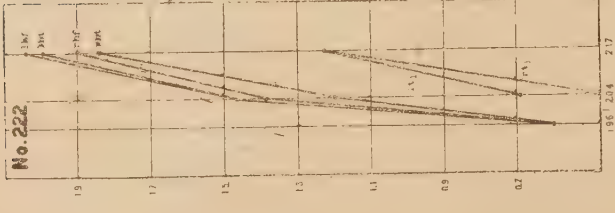
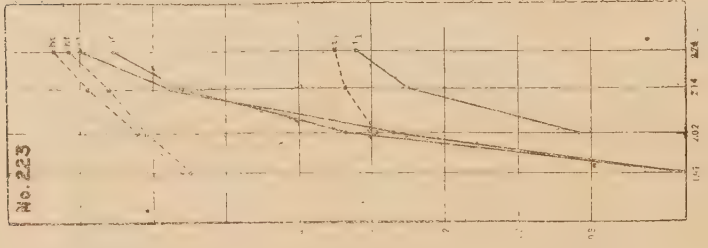
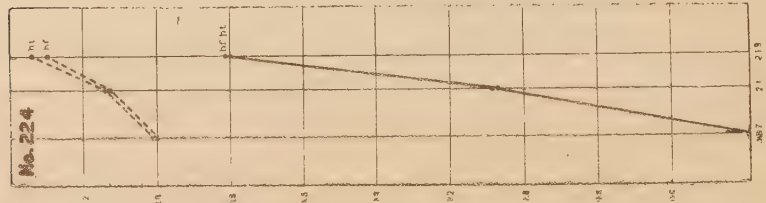
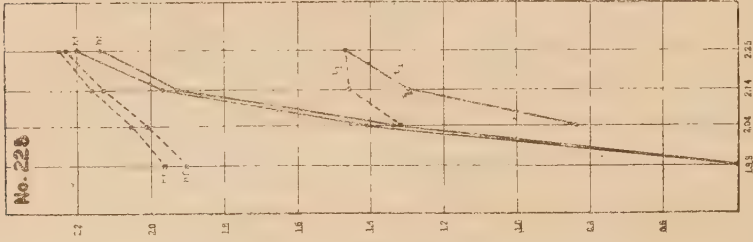
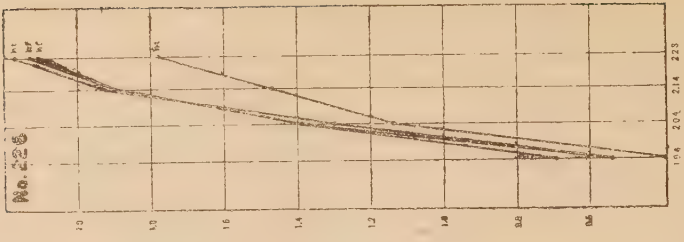


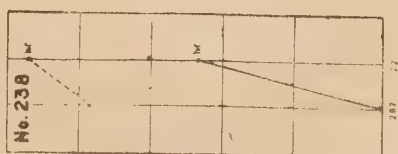
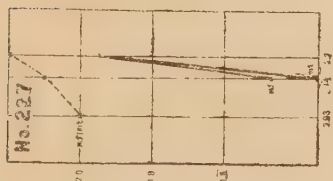
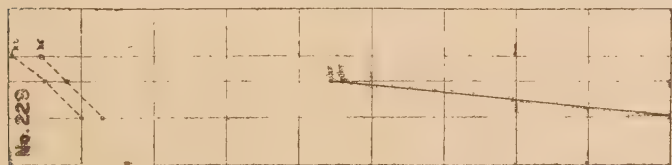
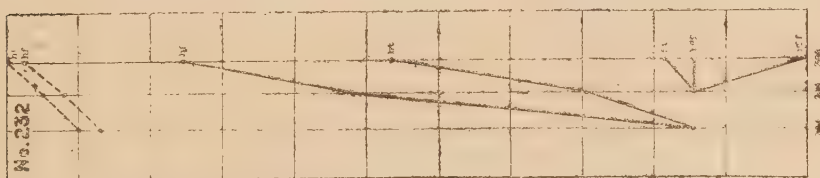
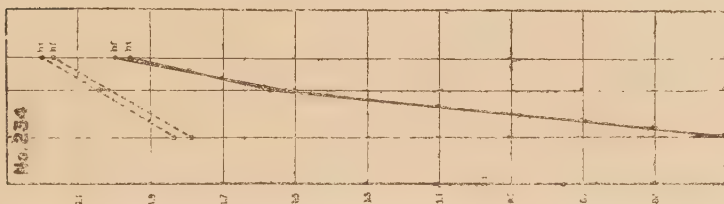
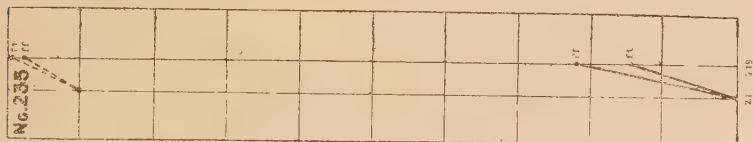
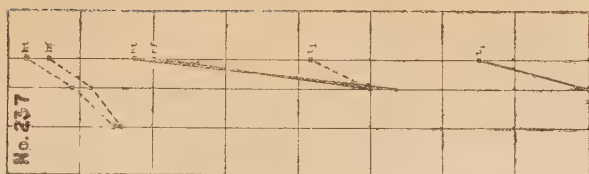


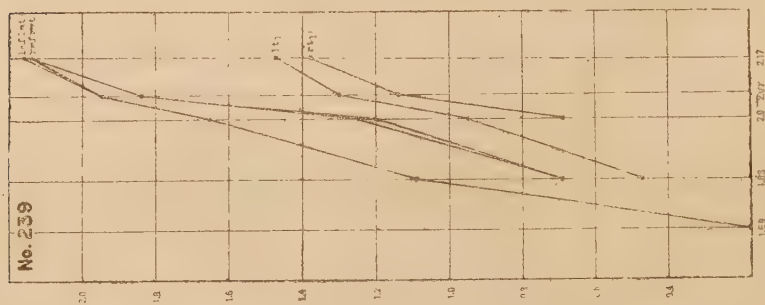
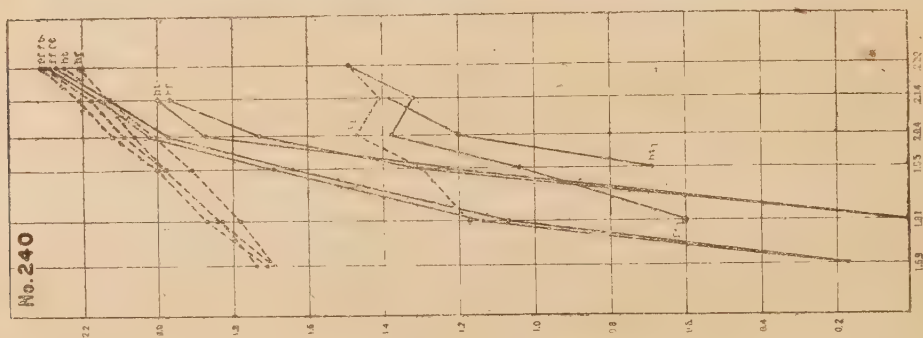
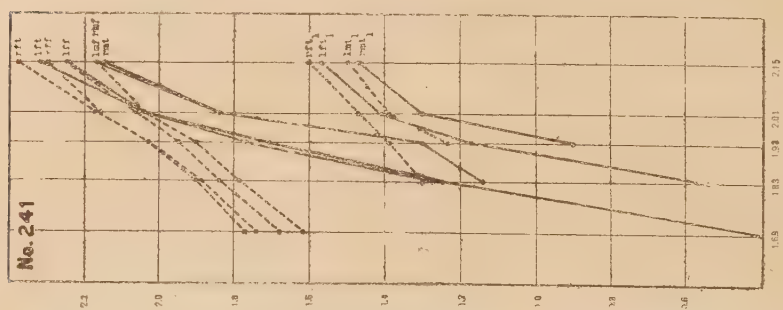
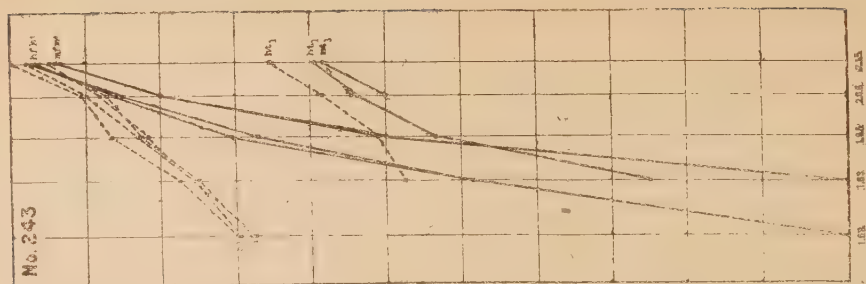


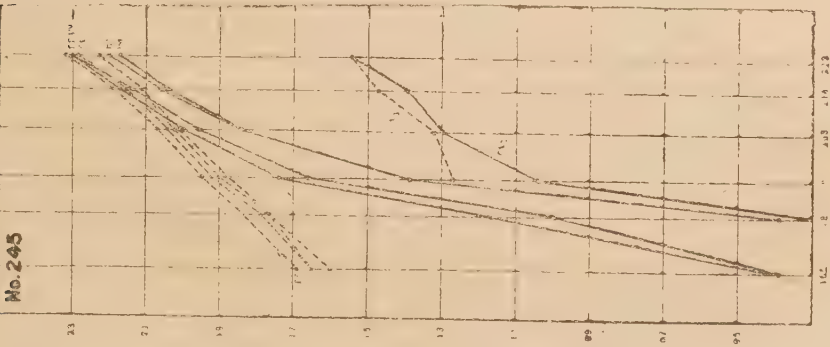
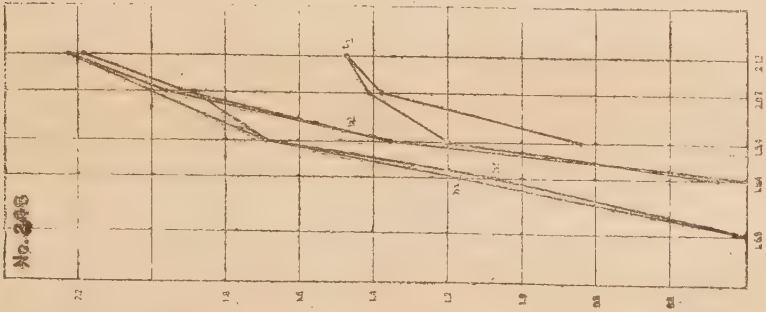
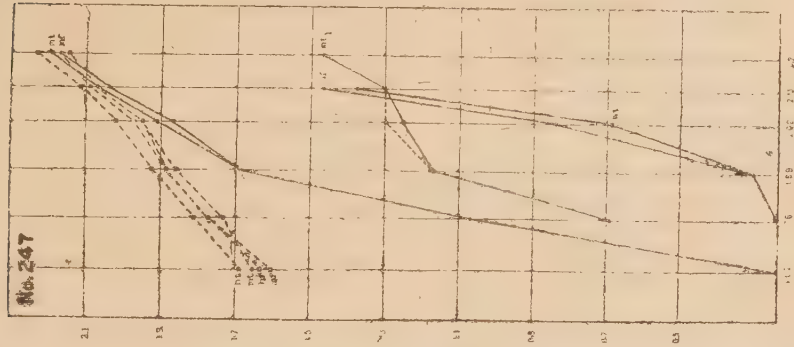
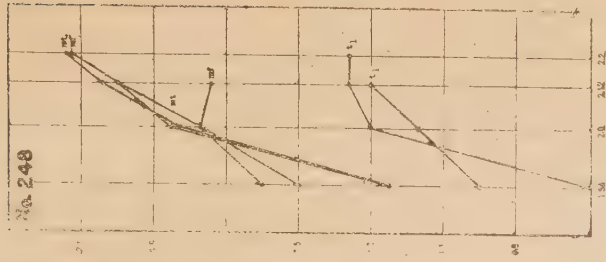


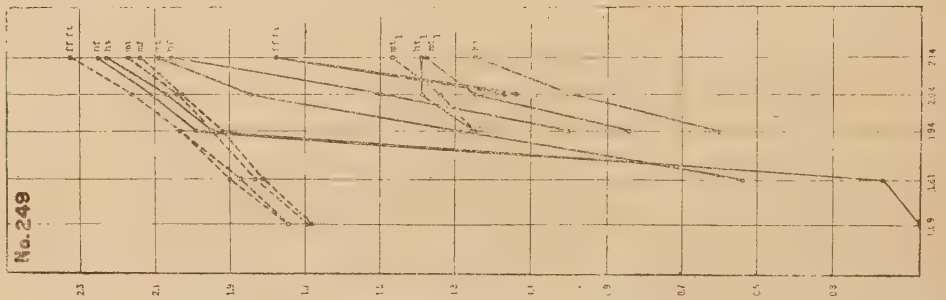
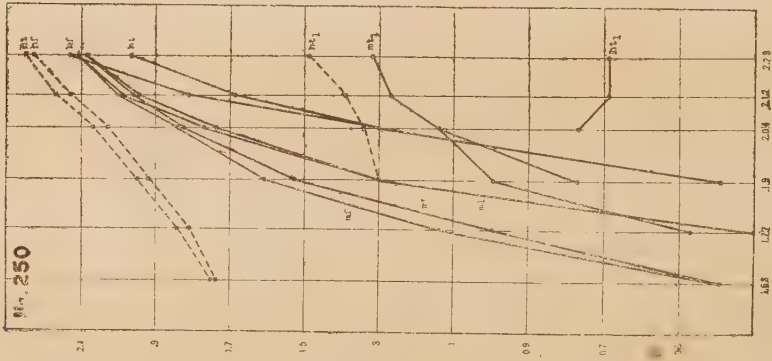
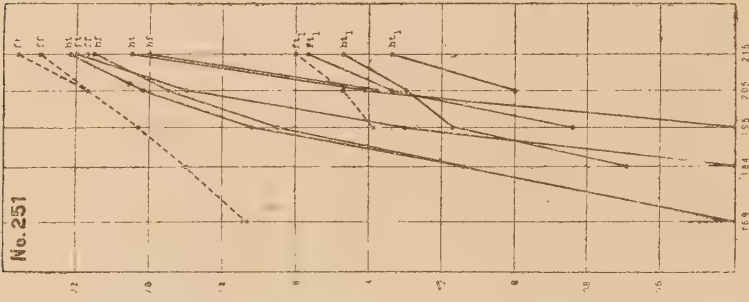
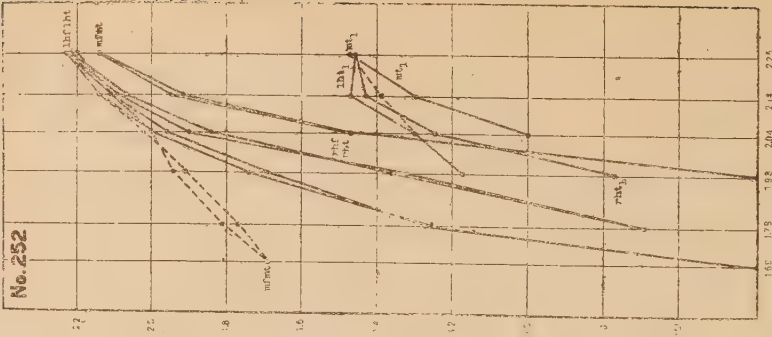


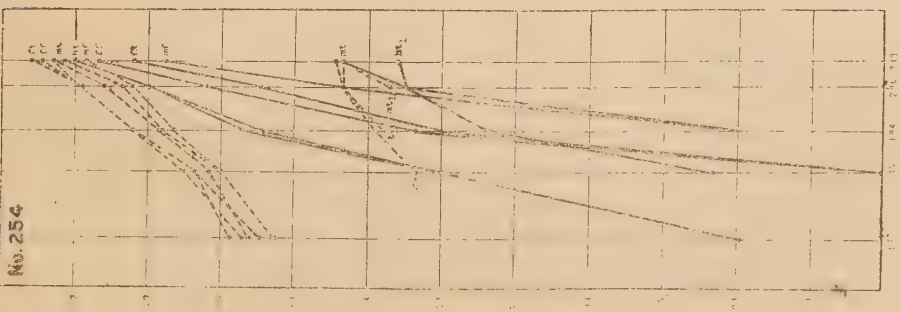
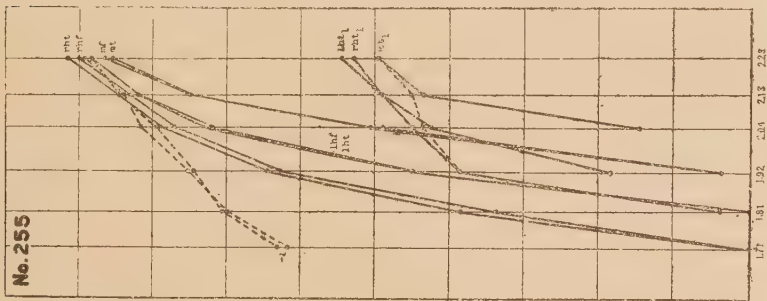
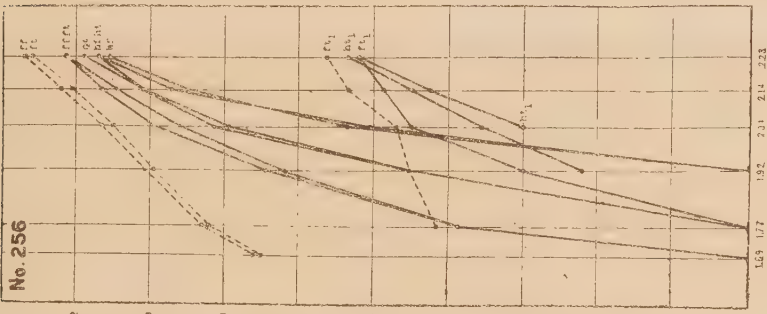
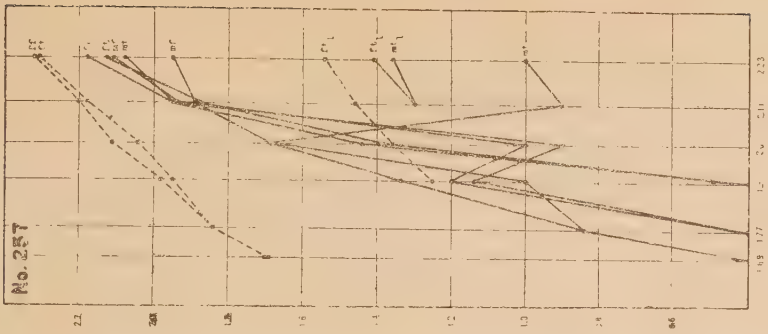


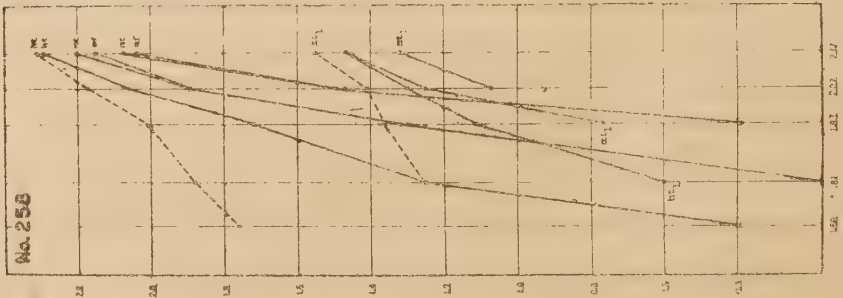
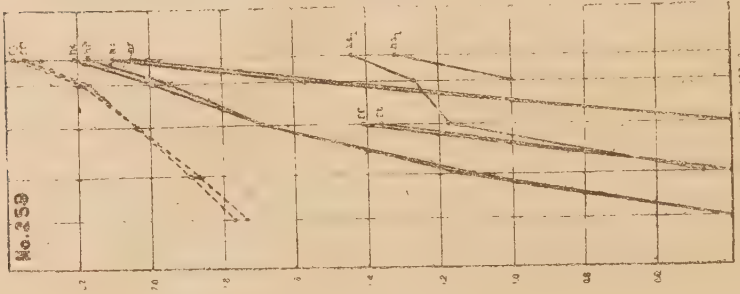
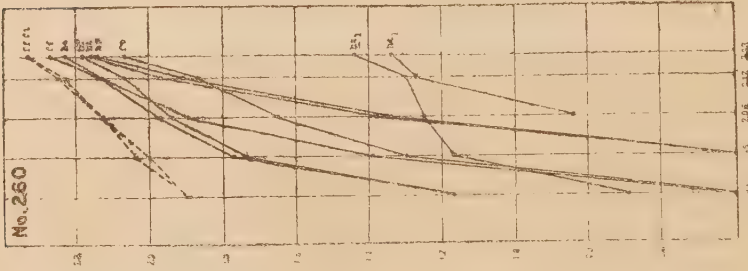
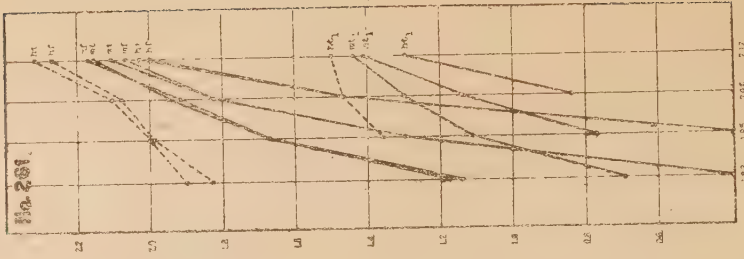


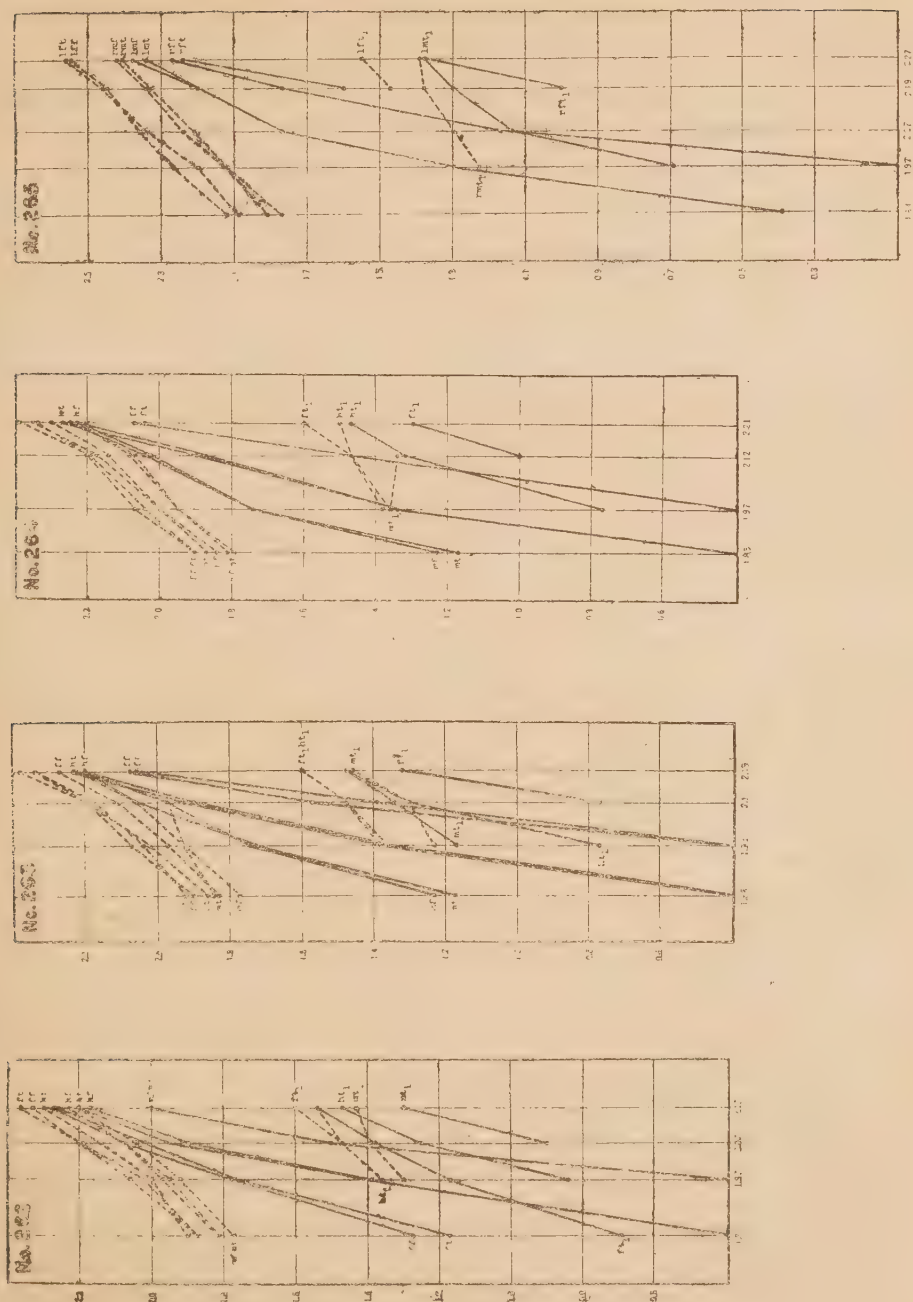


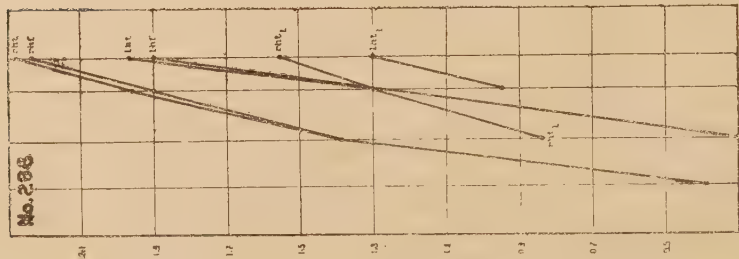
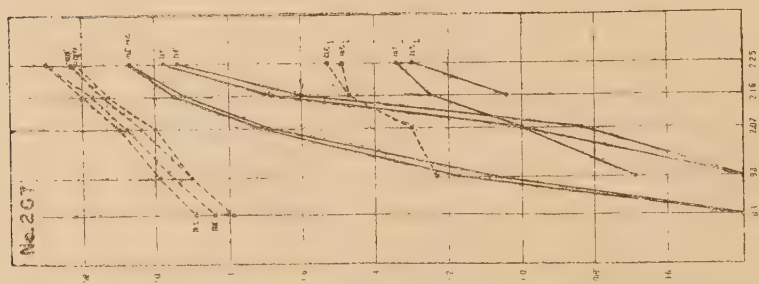
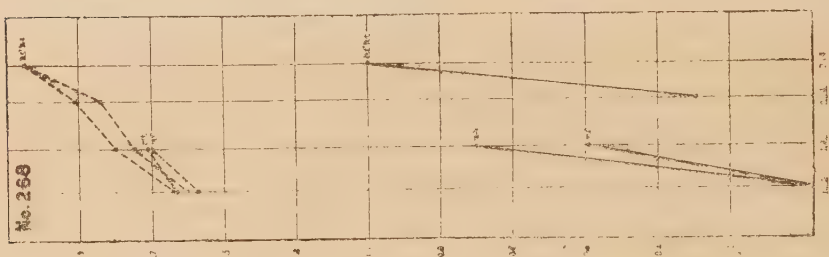
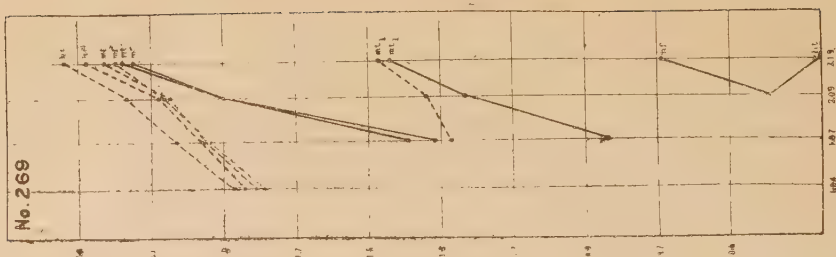


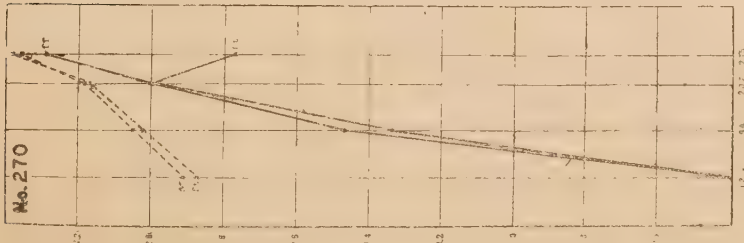
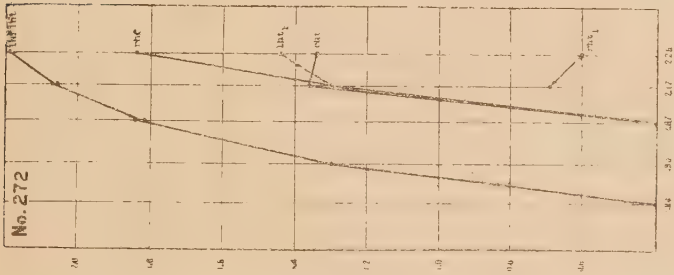
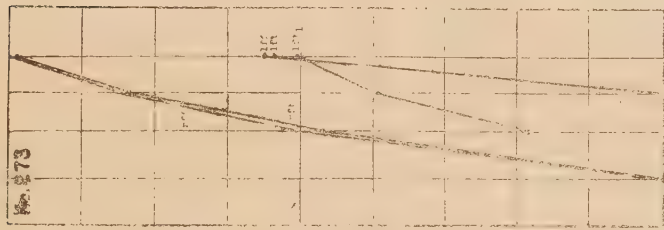
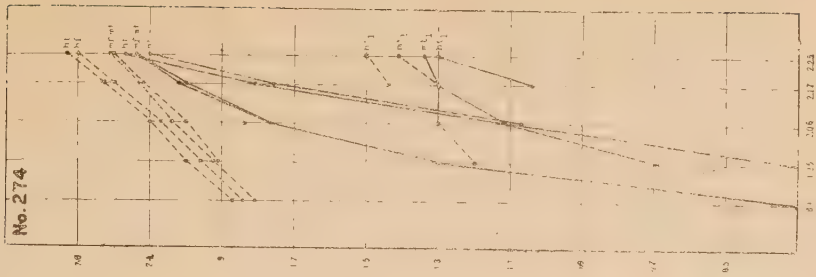


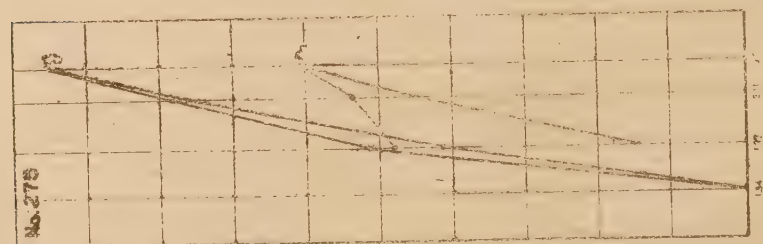
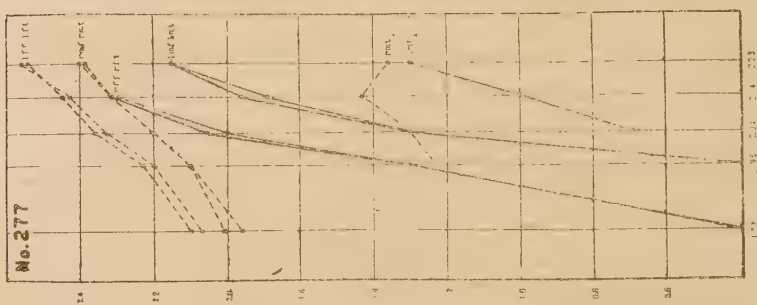
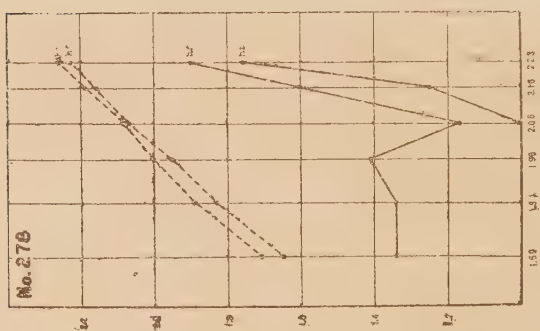
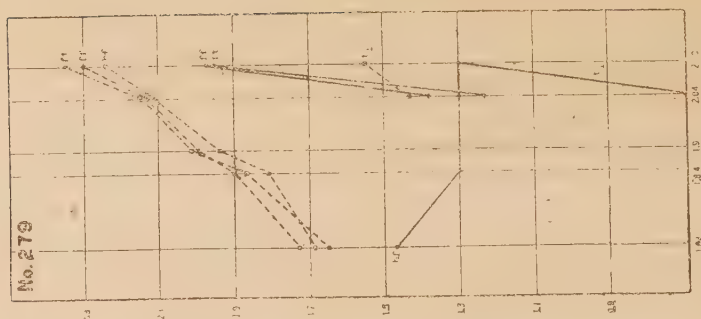


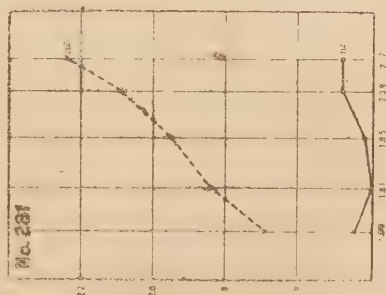
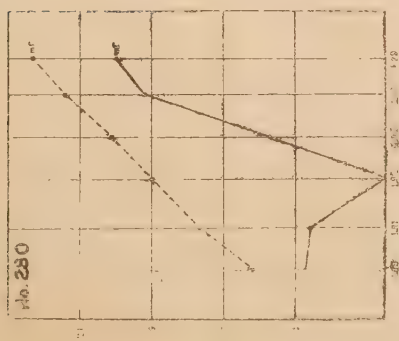
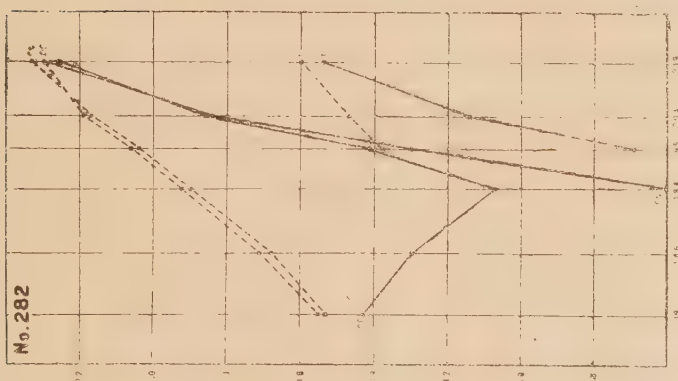
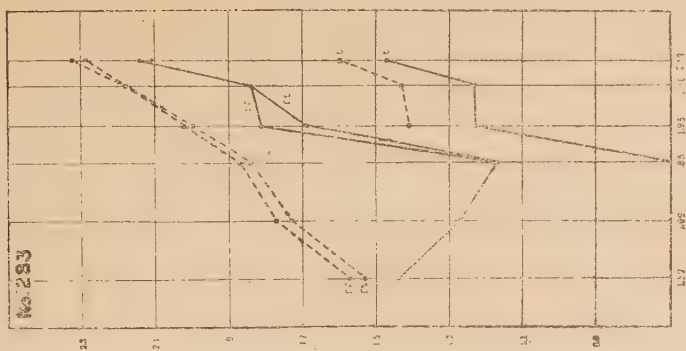


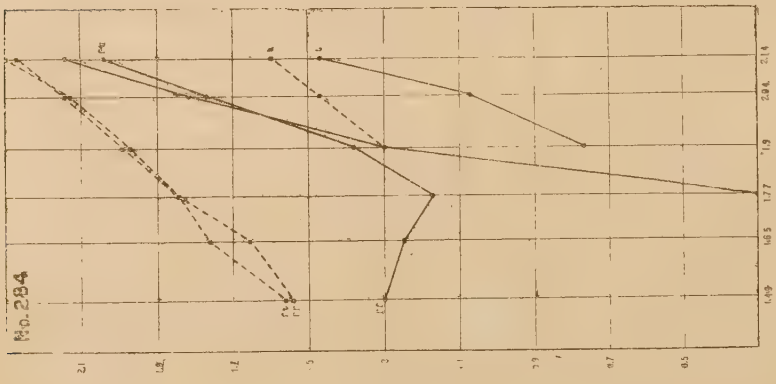
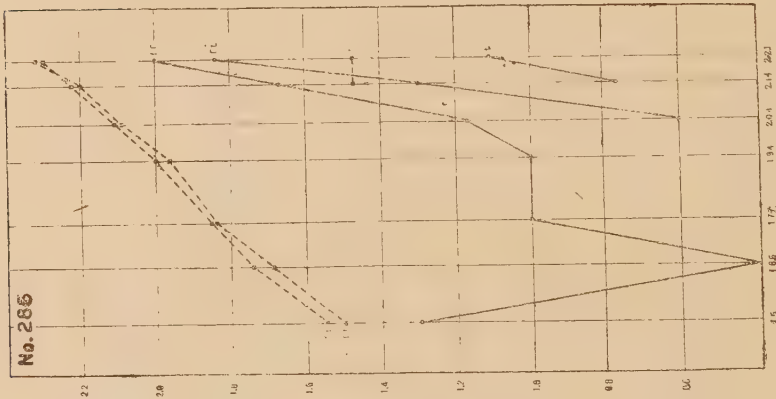
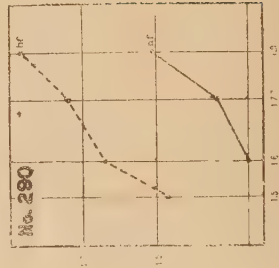
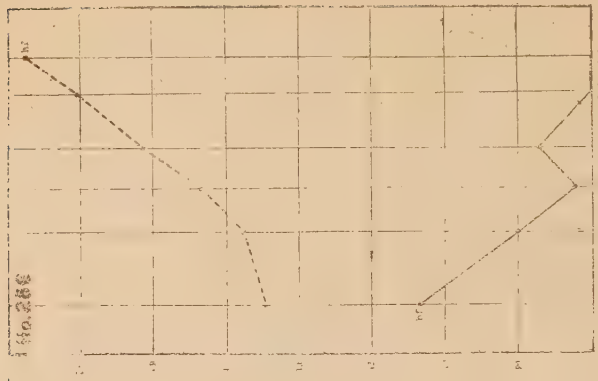


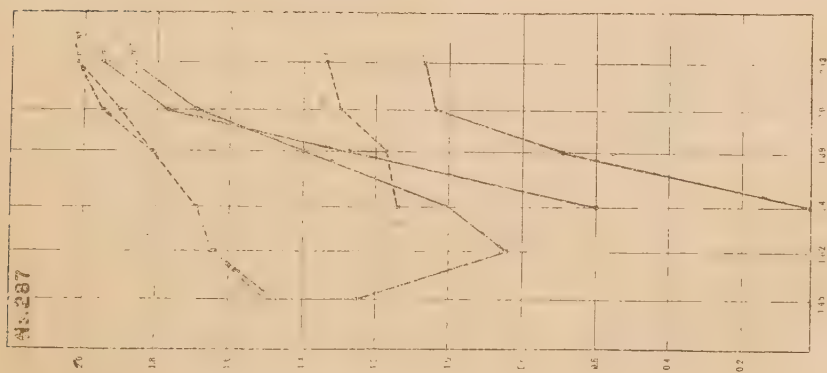
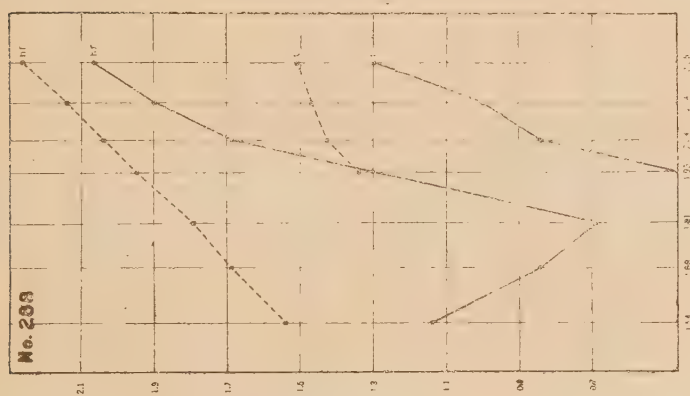
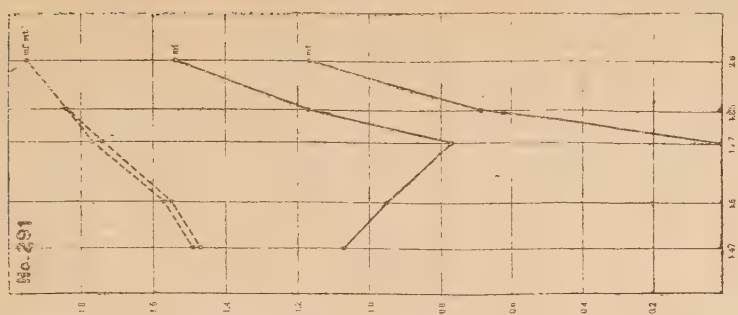


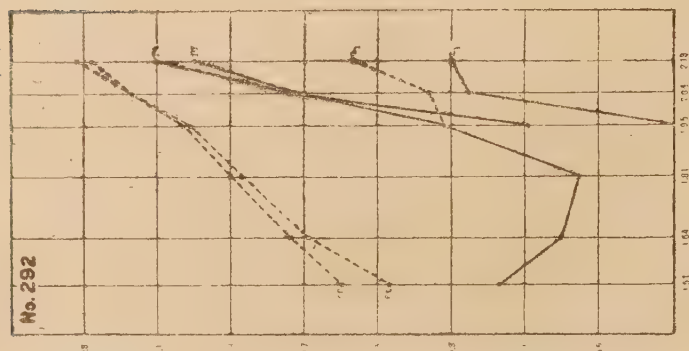
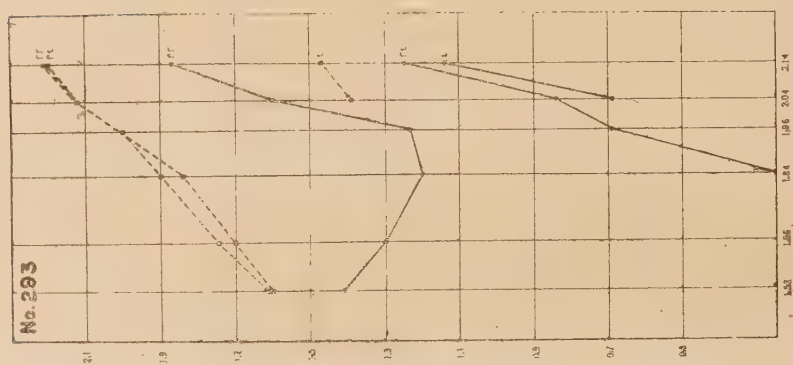
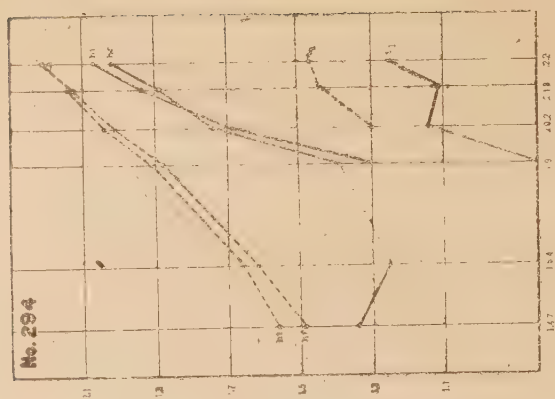


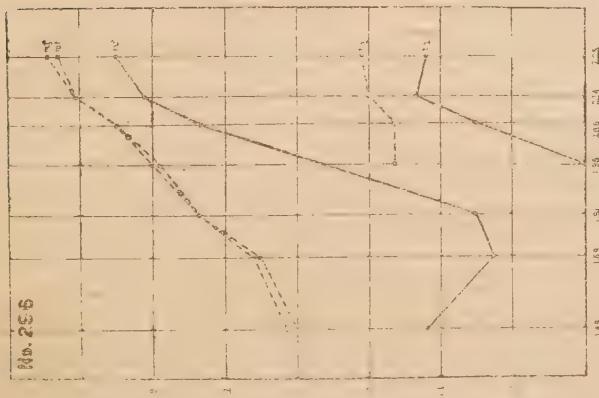
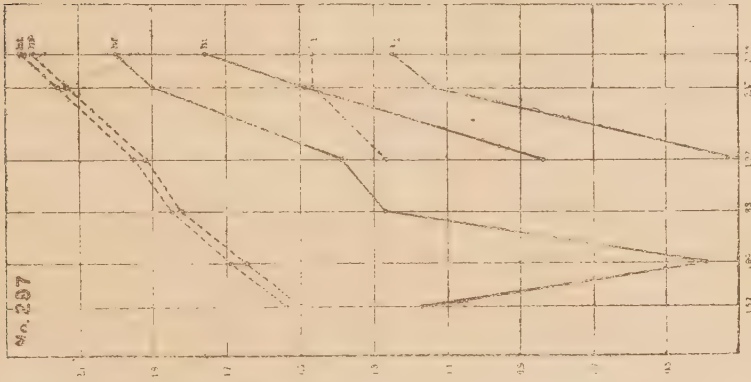
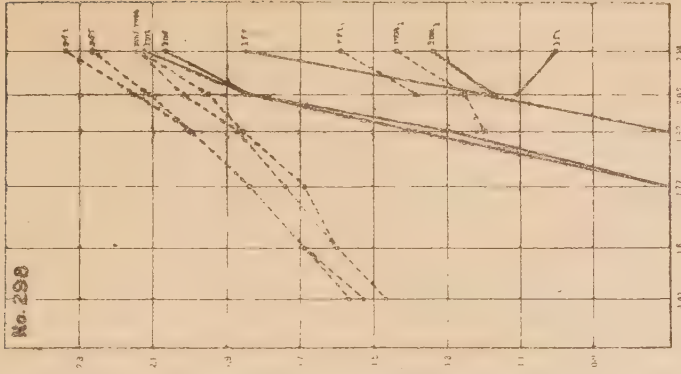


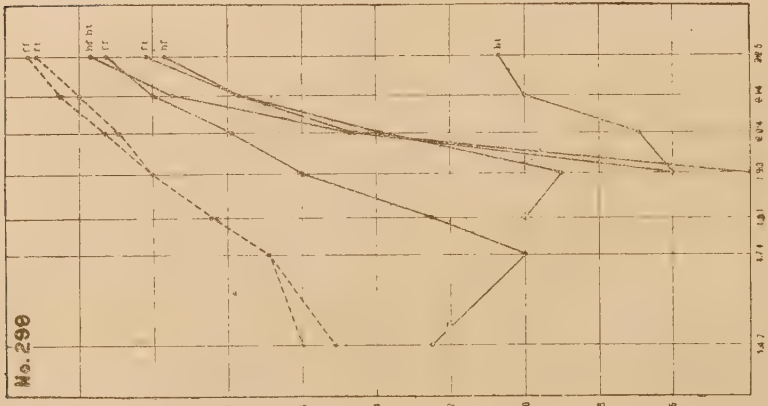
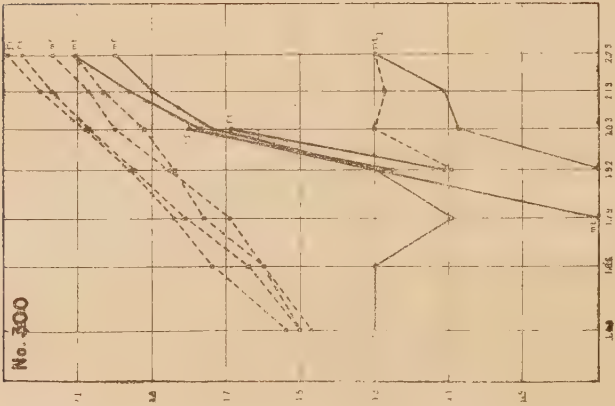
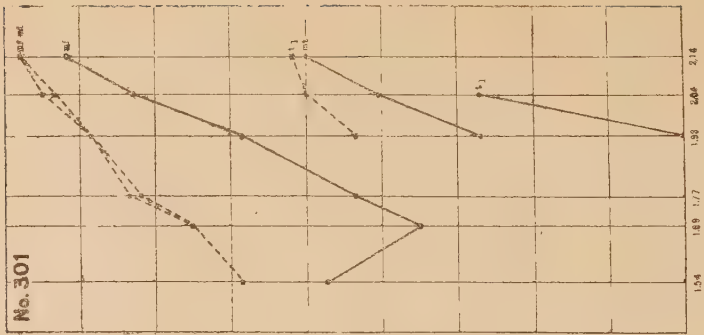












part may be structurally normal yet reduced in size; more often, however, it is of normal size though structurally incomplete. Allometric sexual differences are not reproduced in the regeneration in Phasmids (PRZIBRAM, 1931). Body-wart or leg regeneration may at times be suppressed by transplantation of some other hypodermal part to the site of the amputation, provided with the transplant covering the entire wound-surface. If the transplant does not cover the entire wound-surface, there occurs another regeneration from the free surface in addition to the development of the transplant. In most cases the regeneration is only possible when at least a stump of the organ remains, *i.e.*, a proximal part is capable of regenerating any distal portion, but the animal is incapable of regenerating the entire structure. Regeneration is controlled by the organ stump, but not by the position within the body. In general the first growth of the regenerate is most rapid and the initially accelerated growth diminishes in velocity with age. In other words, during the process of regeneration its growth-ratio is much higher than normal, and will gradually sink until it reaches the normal value, at which it will be maintained. Regeneration is simply a special case of growth and the normal growth-ratios of an organ merely represent a limited value of it. Relative size of organs appears to be determined in the first instance as an equilibrium between the amount of material in the organ and the amount of material in the body, the equilibrium being determined according to the general formula $y = bx^a$. If the equilibrium be upset, regulation towards the equilibrium status will take place during later growth. The particular mechanism by which the equilibrium is attained does concern growth-ratio; the more the organ is below equilibrium-size, the higher will be its growth-ratio. The muscles in the regenerate appendages may appear in the adult, when the ganglion of the segment is left intact. A leg or antenna may regenerate externally normally but without muscles or nerves when both the appendage and the ganglion to which it is connected are extirpated. In *Dixippus* FRIEDRICH (1930) found that the order of regeneration of the internal tissues of the leg is nerves and tracheae then muscles and sense organs, and he thought that the tissues are all derived from the epidermal parts of the organ-stump. Regeneration of epidermal structures is independent of the nervous system; re-

generation of muscles is dependent upon their innervation. In Orthopterous insects the autotomy of a leg occurs at the trochantero-femoral suture or groove. BORDAGE found that the parts capable of regeneration are different according to groups, *i.e.*,—in Phasmida, from the middle portion of the tibia to the apex of the third tarsal segment, in Mantodea from the middle portion of the femur to the apex of the third tarsal segment, in Blattariae from the middle portion of the femur to the apical end of the tibia. PRZIBRAM is the first zoologist who proposed the general formula expressing the regeneration as a function of time in Arthropoda. He offered the following law enunciated for *Sphodromantis bioculata* in 1917:

$$Z - n - r = \frac{K}{t \cdot Va} \cdot \frac{R}{r},$$

where Z is the normal final length of the regenerated leg, n is the length after amputation, r is the length at the end of the time t, Va is the normal coefficient of increase of the leg between one moult and the next. In 1933 ANDERSON studied the regeneration of *Daphnia magna* and gave the following formula:

$$Y = a(x - y)^k,$$

where y is the length of the regenerated part, and x designates the surface area of the wound. Most interesting is the general law of PAULIAN (1938). His formula is:

$$Q = \frac{T}{e^{at} + b} \quad \text{or} \quad \frac{T}{\log Q} = aT + b,$$

where Q is the quantity of the regenerated part at the age t. This relation can be expressed by a straight line when plotted graphically. PAULIAN applied this formula to various groups of animals such as Planaria, *Ophiothrix fragilis*, *Antedon mediterraneum*, *Polynoe scolopendrina*, *Gammarus pulex*, *Crangon vulgaris*, *Leander serratus*, *Palaemon squilla*, *Chloeon dipterum*, *Carausius morosus*, *Rana temporaria*, *Molge punctatum*, etc.

2. Increase in length

In the following tables (9 and 13) are given growth-ratios (not in Chapter I) of the lengths of the regenerate appendages in the

course of the post-embryonic development. These data show definitely the tendency that the growth-ratios in the regenerate appendages are diminishing during development. Generally the growth-ratios between the first and subsequent regenerates show a marked tendency to exceed the value required by PRZIBRAM's theory, even much more than 2. Of course the growth-ratios in the regenerate appendages show considerable variation in the values for different instars. In my experiments 38.00 was the maximum value for growth-ratio (No. 100).

The percentage length (β') of any allometric organs in each instar was calculated by the following formula:

$$\beta' = \frac{\text{Length of the regenerate in the instar } n}{\text{Ultimate length of the regenerate}} \times 100,$$

and the results are shown in the table 10 and text-figure 4 given below. From these tables we may be able to point out that β' takes the value fairly equal to those of discussed in the preceding chapter in the preadult instar and β' previous to the preadult instar are much smaller than those of β . In general the β' never exceed a value 10 in the instar when the regenerate was first appeared or even in the succeeding instars.

3. Recovering in length of regenerating legs

In the present section the recovering in length of regenerating legs is considered. The fact that regeneration can be regarded as an accelerated growth as pointed out by PRZIBRAM (1919) shows the existence of a very high velocity in the growth of the regenerate, and the phenomenon that the regenerated appendages frequently equal the normal ones by the time when adulthood is reached must be remembered. Thus the difference in length between a regenerated and the normal leg becomes smaller ecdysis after ecdysis. For convenience' sake I want to call this difference in length as convergence in length between regenerating and normally growing legs and calculated the convergency quotient δ by the following formula:

δ of any appendage =

$$\frac{\text{Length of normal appendage} - \text{Length of a regenerate}}{\text{Length of normal appendage}} \times 100.$$

[illegible]

[illegible]

No.	1		2							92
	FT	FF	FT	FF	MT	MF	HT	HF	t ₁	t ₂
VI : I										
VI : II			48.57	50.86						
VI : III			11.33	10.15	24.00	24.20				
VI : IV										
VI : V			2.27	1.85	2.00	2.02	4.60	4.33	1.67	1.67
VI : VI			1.26	1.53	1.33	1.34	1.55	1.51	1.39	1.25
VI : I										
VI : II			38.57	33.14						
VI : III			9.00	6.62	18.00	18.00				
VI : IV										
VI : V			1.80	1.21	1.50	1.50	3.00	2.67	1.20	1.62
V : I										
V : II			21.43	27.43						
V : III			5.00	5.48	12.00	12.00				
V : IV										
IV : I										
IV : II										
IV : III										
III : I	1.79	2.35								
III : II	1.35	1.43	4.29	5.00						

No.	10						11		94
	HT	HF	HT	HF	t ₁	t ₂ ² ₄	t ₁	t ₂ ² ₄	
VII : I	32.00	34.00	25.60	32.20					FT
VII : II	10.67	11.33	7.31	9.47					
VII : III									
VII : IV									
VII : V	5.33	1.89	2.51	1.63	4.00	1.75	2.08	1.40	
VII : VI	1.68	1.38	1.42	1.32	1.33	1.19	1.24	1.20	1.27
VI : I									
VI : II	19.00	24.60	18.00	24.40					
VI : III	6.33	8.20	5.14	7.18					
VI : IV									
VI : V	3.17	1.37	1.76	1.23	3.00	1.47	1.68	1.17	1.32
V : I									
V : II	6.00	18.00	10.20	19.80					
V : III	2.00	6.00	2.91	5.82					
V : IV									
IV : I									
IV : II									
IV : III									
III : I									
III : II	3.00	3.00	3.50	3.40					

No.	48		49				50	70
	HT	HF	FT	FF	FT	FF	A	A
VI : I								
VI : II								
VI : III								
VI : IV								
VI : V								
VI : VI								
VI : I								
VI : II	8.00	18.00						5.25
VI : III	4.44	10.00						3.88
VI : IV								
VI : V	2.00	1.61						1.48
V : I							6.40	
V : II	4.00	11.20	22.86	22.29			4.16	3.56
V : III	2.22	6.22	12.31	12.00	8.00	5.00	2.54	2.63
V : IV			2.05	2.44	1.47	2.20	1.49	
								1.67
IV : I							4.31	
IV : II			11.14	9.14			2.80	
IV : III			6.00	4.92	5.43	2.27	1.71	
III : I							2.52	
III : II	1.80	1.80	1.86	1.86			1.64	1.36

No.	59 b				76			98	
	FT	FF	MT	MF	t ₁	t ₂	FT	HT	HF
VII : I									
VII : II									
VII : III									
VII : IV									
VII : V								40.80	52.00
VII : VI								3.40	3.46
VI : I									
VI : II									
VI : III									
VI : IV	9.84	9.24	8.80	8.00					
VI : V	3.51	3.05	2.97	2.78				12.00	12.00
V : I									
V : II							4.16		
V : III							4.00		
V : IV	2.80	3.04	2.96	2.85	2.25	1.75	1.61	2.00	1.25
VI : I									
VI : II									
VI : III									
III : I									
III : II									
III : III									
III : IV									
III : V									
III : VI									
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III : XL									
III : XLI									
III : XLII									
III : XLIII									
III : XLIV									
III : XLV									
III : XLVI									
III : XLVII									
III : XLVIII									
III : XLIX									
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No.	3			4		5		6	
	MT	MF	t ₁	MT	MF	HT	HF	HT	HF
VI : I									
VI : II	69.50	67.50		32.50	33.75			35.00	35.00
VI : III	11.12	11.74		14.44	10.38	28.75	28.50	10.77	10.00
VI : IV	8.69	5.00		7.43	3.60	8.21	8.07	7.00	4.12
VI : V	3.86	2.21	3.71	3.33	1.93	2.88	2.85	2.80	2.03
VI : VI	1.54	1.41	1.44	1.63	1.35	1.44	1.43	1.43	1.40
VI : I									
VI : II	45.00	48.00		20.00	25.00			23.75	25.00
VI : III	7.20	8.35		8.89	7.69	20.00	20.00	7.31	7.14
VI : IV	5.62	3.56		4.57	2.67	5.71	5.71	4.75	2.94
VI : V	2.50	1.57	2.57	2.05	1.43	2.00	2.00	1.90	1.45
V : I									
V : II	18.00	30.50		9.75	17.50			12.50	17.25
V : III	2.88	5.30		4.33	5.38	10.00	10.00	3.85	4.93
V : IV	2.25	2.26		2.23	1.87	2.86	2.86	2.50	2.03
IV : I									
IV : II	8.00	13.50		4.88	9.38			5.00	8.50
IV : III	1.28	2.35		1.94	2.88	3.50	3.50	1.54	2.43
III : I									
III : II	6.25	5.75		2.25	3.25			3.25	3.50

No.	12		13		14	15		17		18
	FT	FF	FF	t ₁	MF	MT	MF	MT	t ₁	A
VII : I			6.53		6.67					
VII : II			8.53		6.67					
VII : III			10.28		10.00					
VII : IV			5.82		5.26					
VII : V			2.56	3.20	3.64					
VII : VI			1.41	1.60	1.67					
VI : I		6.32	5.35		4.00					
VI : II		9.24	6.07		4.00	100.00	100.00			
VI : III	13.60	6.86	9.10		6.00	20.00	20.00			
VI : IV	13.60	4.00	4.14		3.16	7.50	5.36			
VI : V	2.72	1.85	1.82	2.00	2.18	1.88	1.88			
V : I		3.42	2.89		1.83			3.33		8.39
V : II		5.00	3.33		1.83			3.57		4.73
V : III	5.00	3.71	5.00		2.75			4.00		2.74
V : IV	5.00	2.17	2.27		1.97	4.00	2.86	2.22	1.25	1.63
IV : I		1.58	1.29		1.27			1.50		5.16
IV : II		2.31	1.47		1.27			1.61		2.91
IV : III	1.00	1.71	2.20		1.90	2.67	3.73	1.80		1.68
III : I		0.92	0.59		0.67			0.83		3.06
III : II		1.35	0.67		0.67	5.00	5.00	0.89		1.73

No.	22				23			24		19
	HT	HF	t ₁	t ₂₋₄	FT	t ₁	t ₂₋₄	MT	t ₁	
VII : I										A
VII : II	63.60									
VII : III	15.90	15.30								
VII : IV	5.48	4.50								
VII : V	2.27	2.01	2.67	1.90						
VII : VI	1.38	1.37	1.33	1.09						
VI : I					11.67			5.31		7.62
VI : II	46.00				9.21			4.25		5.33
VI : III	11.50	11.20			5.65			3.40		3.43
VI : IV	3.97	3.29						2.66		2.21
VI : V	1.64	1.47	2.00	1.75	1.52	1.50	1.17	1.31	1.50	1.35
V : I										5.48
V : II	28.00				7.67			4.06		3.83
V : III	7.00	7.60			6.05			3.25		2.47
V : IV	2.41	2.24			3.71			2.60		1.59
IV : I								2.03		3.45
IV : II	11.60							2.00		2.42
IV : III	2.90	3.40						1.60		1.56
III : I								1.28		2.21
III : II	4.00				2.07			1.56		1.55
III : III					1.63			1.25		

No.	25			27			30				
	HT	HF	t ₁	t ₂₋₄	t	t ₁	t ₂₋₄	MT	MF	HT	HF
VII : I											
VII : II		31.80									
VII : III	13.04	15.90									
VII : IV	3.95	3.98									
VII : V	2.00	2.12	1.63	1.25							
VII : VI	1.30	1.38	1.11	1.00							
VI : I											
VI : II		23.00						21.00	25.00	23.80	24.00
VI : III	10.00	11.50						6.00	7.14	6.80	6.86
VI : IV	3.03	2.88			4.25						
VI : V	1.53	1.53	1.41	1.25	1.70	2.25	1.33	1.31	1.39	1.49	1.35
V : I											
V : II		15.00						16.00	18.00	16.00	17.80
V : III	6.52	7.50						4.57	5.14	4.57	5.09
V : IV	1.97	1.88			2.50						
IV : I											
IV : II		8.00									
IV : III	3.30	4.00									
III : I											
III : II		2.00						3.50	3.50	3.50	3.50

No.	37					39	40				
	HT	HT	HF	HF	t ₁		PT	FF	t ₁	t ₂	t ₂
VII : I						A					
VII : II	64.00	62.00	59.60	58.80							
VII : III	21.33	20.67	19.87	19.60							
VII : IV	8.00	7.75	7.45	7.35							
VII : V	2.16	2.09	2.29	2.26							
VII : VI	1.45	1.41	1.37	1.35	1.25						
					1.10						
VI : I											
VI : II	44.00	44.00	43.80	43.80		9.28	25.60	30.00			
VI : III	14.67	14.67	14.53	14.53		5.68	11.64	11.54			
VI : IV	5.50	5.50	5.45	5.45		3.72					
VI : V	1.49	1.49	1.68	1.68		1.86	1.75	1.53	2.35	1.60	
V : I											
V : II	29.60	29.60	26.00	26.00		5.00	14.60	19.60			
V : III	9.87	9.87	8.67	8.67		3.04	6.64	7.54			
V : IV	3.70	3.70	3.25	3.25		2.00					
VI : I											
VI : II	8.00	8.00	8.00	8.00		2.50					
VI : III	2.67	2.67	2.67	2.67		1.52					
III : I											
III : II	3.00	3.00	3.00	3.00		1.64	2.20	2.60			

No.	45					47				
	MT	MF	HT	HF	t ₁	t ₂	MT	MF	t ₁	t ₂
VI : I										
VI : II							25.40	26.40		
VI : III							12.70	14.67		
VI : IV							4.54	4.13	5.43	6.33
VI : V										
VI : VI							1.35	1.32	1.36	1.27
VI : I										
VI : II	45.71	41.71	54.29	48.00		10.67	18.80	20.00		
VI : III	11.85	11.68	15.20	12.44		4.21	9.40	11.11		
VI : IV							3.36	3.13	4.00	5.00
VI : V	1.62	1.64	1.78	1.73	1.50	1.60				
V : I										
V : II	28.29	25.43	30.57	27.71		6.67				
V : III	7.53	7.12	8.56	7.19		5.00				
V : IV						2.63				
IV : I										
IV : II								6.40		
IV : III								3.56		
III : I										
III : II	3.86	3.57	3.57	3.86		2.53	5.60			
						1.90	2.80			
							2.00	1.80		

No.	44				86			
	HT	HF	HF	t ₁	t ₂₋₄	t ₁	FT	t ₂₋₄
VI : I								
VI : II								
VI : III								
VI : IV								
VI : V								
VI : VI								
VI : I								
VI : II	32.50	15.00	30.00	17.50				
VI : III	13.00	6.00	12.00	7.00				
VI : IV							3.40	
VI : V	1.86	1.54	1.54	1.79	2.00	1.82	2.00	1.67
V : I								
V : II	17.50	9.75	19.50	9.75				
V : III	7.00	3.90	7.80	3.90				
V : IV							1.70	
IV : I								
IV : II								
IV : III								
III : I								
III : II	2.50	2.50	2.50	2.50				

No.	56				57	58		62	60 b
	HT	HF	t ₁	t ₂₋₄		FT	t ₁		
VII : I								MT	A
VII : II									
VII : III	22.00	22.00							
VII : IV	7.50	7.17							
VII : V	2.16	2.20	2.00	1.60					
VII : VI	1.33	1.32	1.25	1.09					
VI : I						1.00		3.75	
VI : II						1.33		2.50	5.60
VI : III	16.53	16.67				1.07	1.93	2.14	
VI : IV	5.63	5.43			5.00	1.07	2.90	1.34	1.89
VI : V	1.63	1.67	1.60	1.45	1.60	1.07			
V : I						0.93		2.80	
V : II						1.25		1.86	2.95
V : III	10.13	10.00				1.00	0.67	1.60	
V : IV	3.45	3.26			3.13	4.00			
IV : I									
IV : II						0.93		1.75	
IV : III	2.93	3.06				1.25		1.17	
III : I									
III : II						0.78		1.50	

[illegible]

No.	58 b				61 b		87
	MT	MT	MF	MF	A	A	
VI : I							t ₁
VI : II							t ₁
VI : III							t ₁
VI : IV	4.50	4.67	4.67	4.93			3.20
VI : V	2.41	2.50	2.50	2.64			3.00
VI : VI	1.34	1.34	1.32	1.42			1.60
VI : I							1.42
VI : II							1.20
VI : III							
VI : IV	3.36	3.50	3.53	3.46	3.00	3.22	
VI : V	1.80	1.87	1.88	1.85	1.50	1.45	2.00
V : I							2.50
V : II							
V : III							
V : IV	1.86	1.86	1.86	1.86	2.00	2.22	
IV : I							1.25
IV : II							
IV : III							
III : I							
III : II							

[illegible]

Table 10. Percentage lengths of the regenerate appendages of *Phraortes kumamotoensis* at different instars of growth. () indicates the figure in Fig. 4.

No.	2		3		4		6		10	
	FT(4)	FF(3)	MT(2)	MF(1)	MT(2)	MF(1)	HT(2)	HF(1)	HT(4)	HF(3)
I										
II	2.06	1.97		1.48	3.08	2.96	2.86	2.86	3.13	2.94
III	8.82	9.83	4.17	4.13	6.92	9.63	9.29	10.00	9.38	8.82
IV					13.46	27.78	14.29	24.29		
V	44.12	53.93	50.00	49.59	30.00	51.85	35.71	49.29	18.75	52.94
VI	79.41	65.17	75.00	74.38	61.54	74.07	67.86	71.43	59.38	72.35
VII	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

No.	10		12		13		14		15		19		22		23	
	HT(2)	HF(1)	FT(2)	FF(1)	FT(1)	FF(1)	FF(1)	FF(1)	MT(2)	MF(1)	Antenna (1)	Antenna (1)	HT(2)	HF(1)	FT(1)	FT(1)
I					15.83	13.28	15.00	15.00			13.13	13.13			8.57	8.57
II	3.91	3.11		10.83	11.72	15.00	15.00	15.00	1.00	1.00	18.75	18.75	1.57		10.86	10.86
III	13.67	10.56	7.35	14.58	7.81	10.00	10.00	10.00	5.00	5.00	29.06	29.06	6.29	6.54	17.71	17.71
IV			7.35	25.00	17.19	19.00	19.00	19.00	13.33	18.67	45.31	45.31	18.24	22.22		
V	39.84	61.49	36.76	54.17	39.06	27.50	27.50	27.50	53.33	53.33	71.88	71.88	44.03	49.67	65.71	65.71
VI	70.31	75.78	100.00	100.00	71.09	60.00	60.00	60.00	100.00	100.00	100.00	100.00	72.33	73.20	100.00	100.00
VII	100.00	100.00			100.00		100.00	100.00					100.00	100.00		

No.	25				32				33				34				38			
	HT(2)	HF(1)	MT	MF	HT(2)	HF(1)	FT(3)	FF(2)	MF(1)	FT(3)	FF(2)	HF(1)	HT(2)	HF(1)	FT(3)	FF(2)	MF(1)	FT(3)	FF(2)	HF(1)
I																				
II		3.14																		
III	7.67	6.29	4.62	4.55	3.61	3.75	4.55	4.63	21.43	3.94	3.83	8.24								
IV	25.33	25.12	15.38	16.67	12.05	12.50	12.12	14.81	64.29	10.53	11.22	23.53								
V	50.00	47.17			42.17	43.75	50.91	55.56	57.14	39.42	43.47	35.29								
VI	76.67	72.33	100.00	100.00	72.29	71.88	100.00	100.00	100.00	64.74	73.98	68.24								
VII	100.00	100.00			100.00	100.00				100.00	100.00	100.00								

No.	36				37				56				77			
	MT(4)	MF(3)	MT(2)	MF(1)	HT(4)	HF(3)	HT(2)	HF(1)	HT(2)	HF(1)	MT(2)	MF(1)	HT(2)	HF(1)	MT(2)	MF(1)
I																
II					1.56	1.61	1.68	1.70								
III	5.36	5.36	5.27	5.27	4.69	4.84	5.03	5.10	4.55	4.55						
IV	17.14	17.14	17.48	17.48	12.50	12.90	13.42	13.61	13.33	13.94	5.79	6.10				
V	44.29	44.29	46.15	46.15	46.25	47.74	43.62	44.22	46.06	45.45	20.63	24.39				
VI	71.43	71.43	69.93	69.93	68.75	70.97	73.15	74.15	75.15	75.76	64.29	65.85				
VII	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00				

No.	44				47			59	78			79	80	
	HT(4)	HF(3)	HT(2)	HF(1)	MT(2)	MF(1)	MT(1)		FT	FF	FT(1)		HT	HF
I														
II	3.08	6.67	3.33	5.71	3.94	3.79								
III	7.09	16.67	8.33	14.29	7.87	6.82	2.92							
IV					22.05	24.24	5.00		3.13	10.53	3.33	10.53	18.75	
V	53.85	65.00	65.00	55.71			33.33		25.00	31.58	13.33	47.37	53.13	
VI	100.00	100.00	100.00	100.00	74.02	75.76	100.00		100.00	100.00	45.33	100.00	100.00	
VII					100.00	100.00					100.00			

No.	86	87	60 b	54 b						57 b	98	
				MT(1)	Antenna	FT(6)	FF(5)	HT(4)	HF(3)		HT	HF
I												
II												
III			17.86									
IV	29.41	35.29						4.97	5.77	30.00		
V	50.00	44.12	52.68			7.08	8.00	16.58	19.23	56.00	2.45	1.92
VI	100.00	70.59	100.00			38.33	36.80	58.28	47.69	100.00	29.41	28.85
VII		100.00				100.00	100.00	100.00	100.00		100.00	100.00

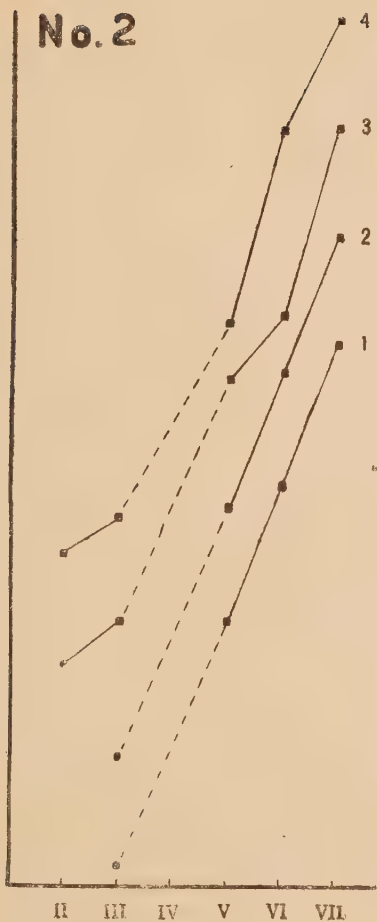
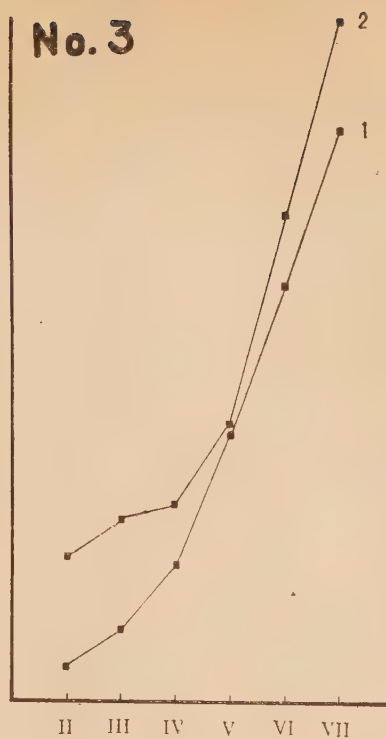
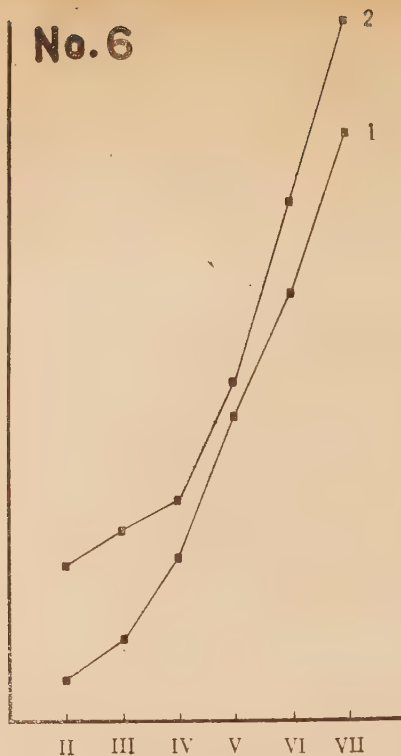


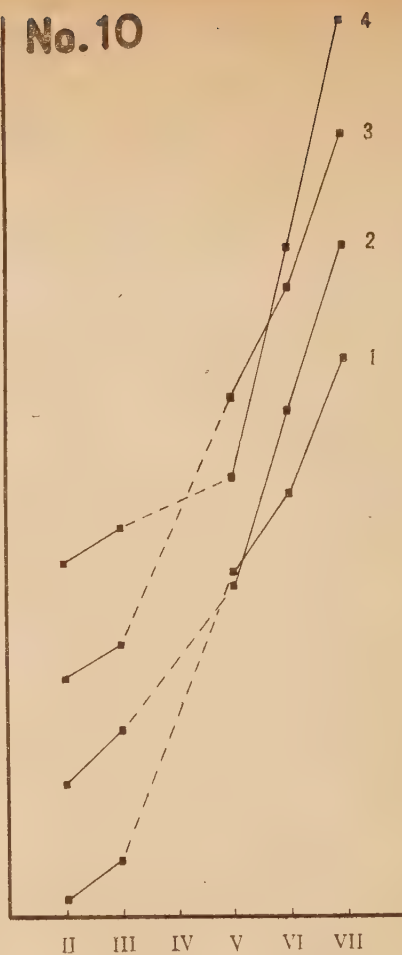
Fig. 4. Percentage lengths of the regenerate appendages of *Phraortes kumamotoensis* at different instars of growth. Abscissa represents the instars.



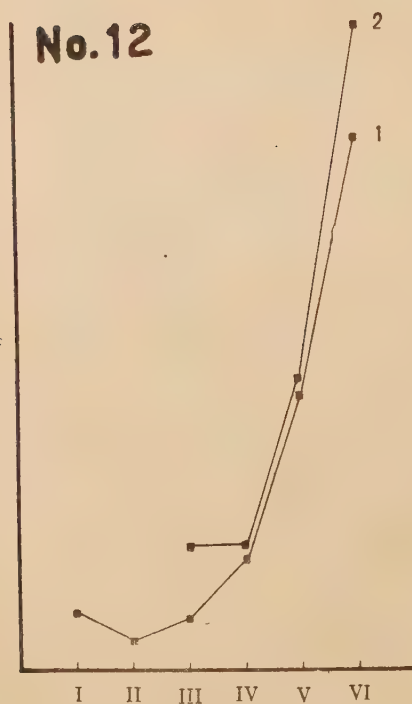
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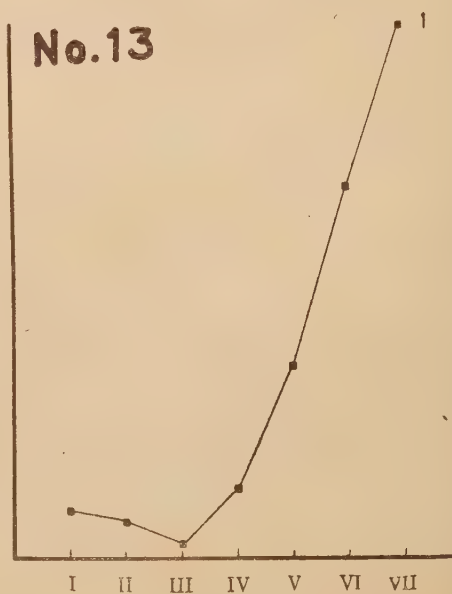
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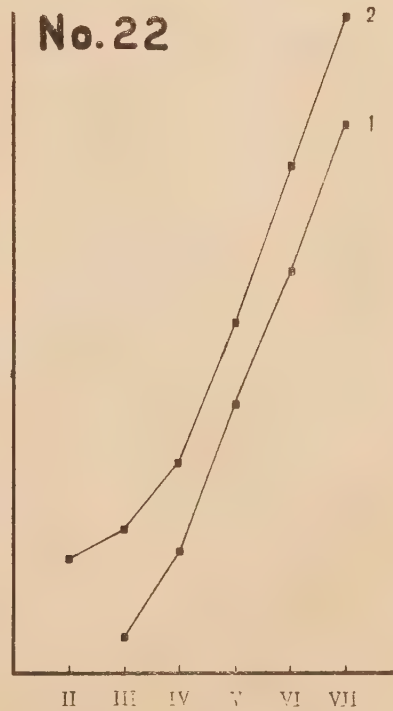
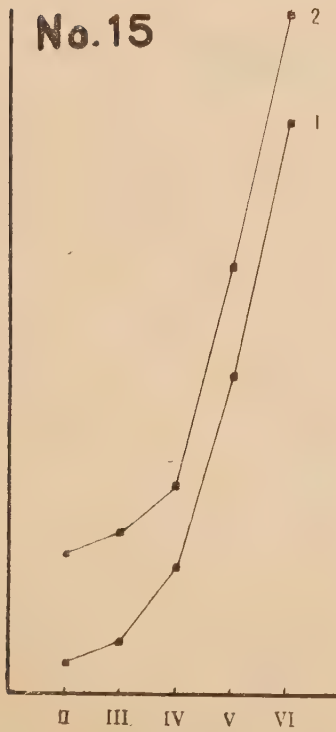
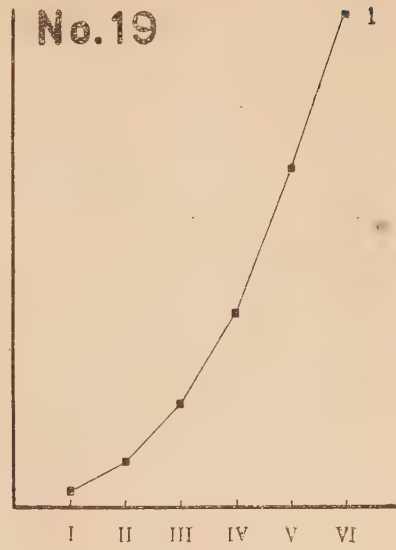
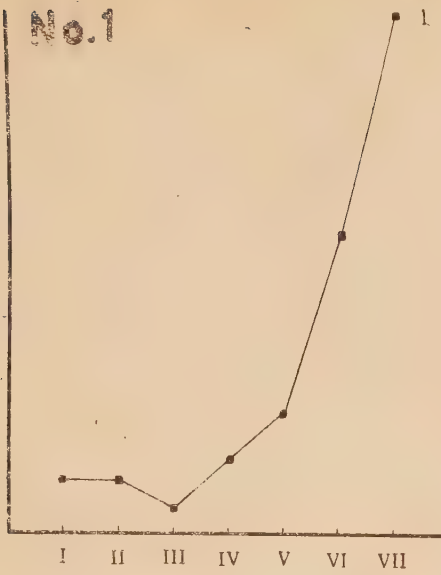


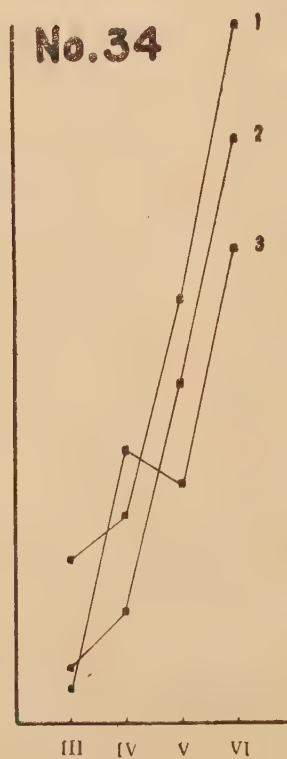
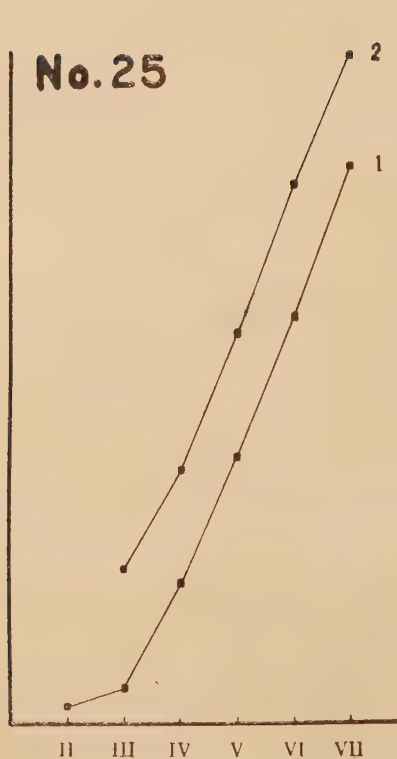
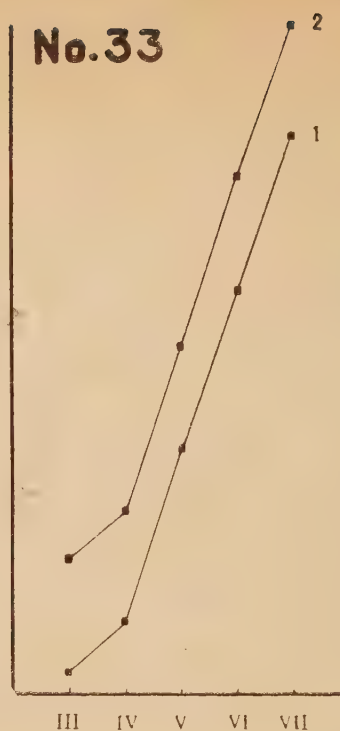
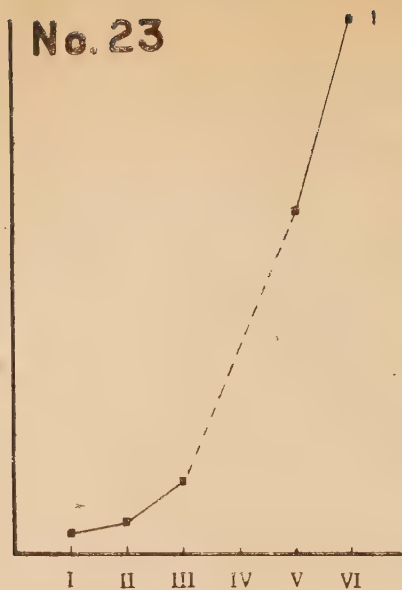
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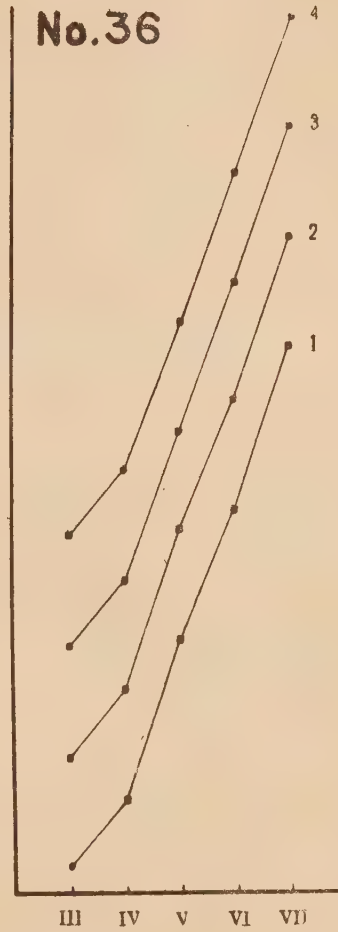


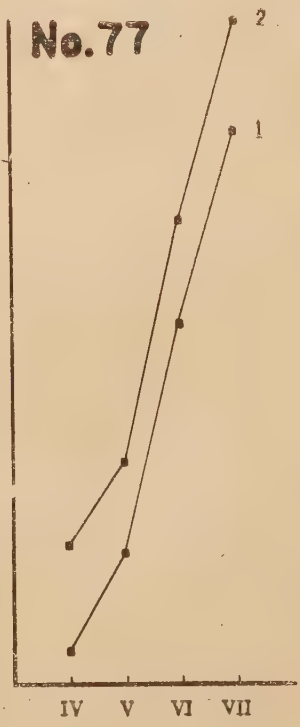
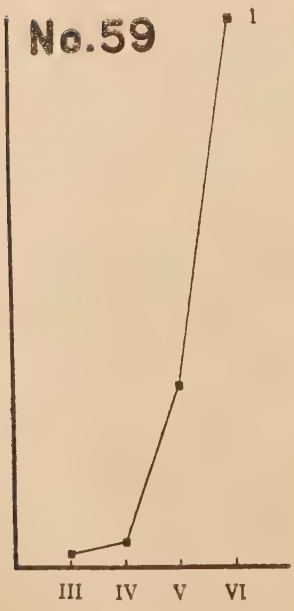
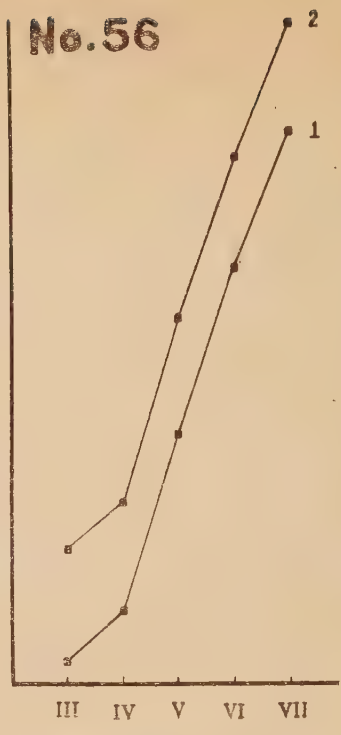
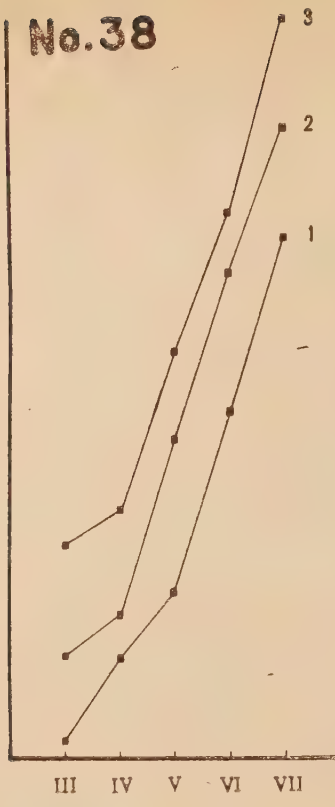
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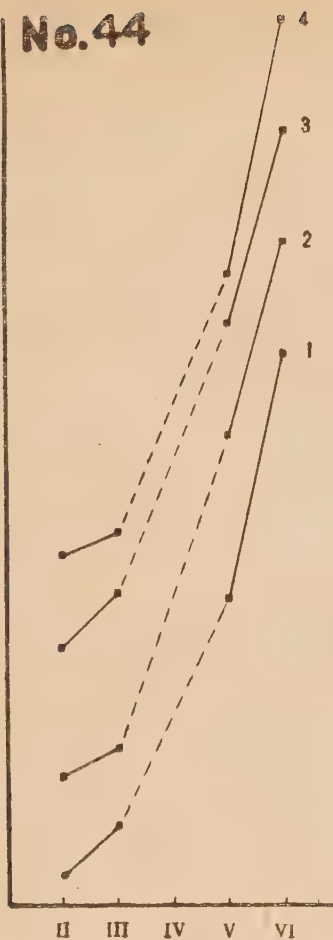




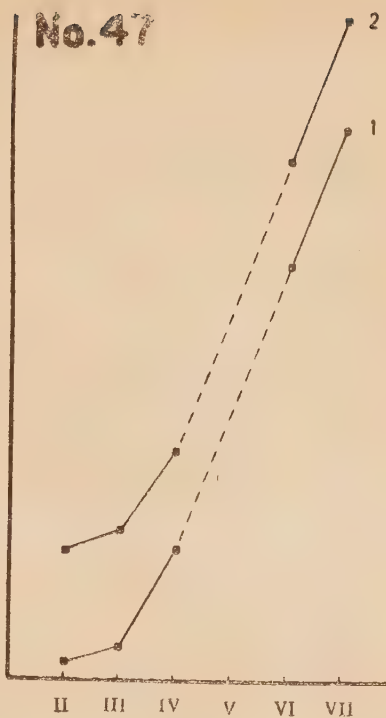




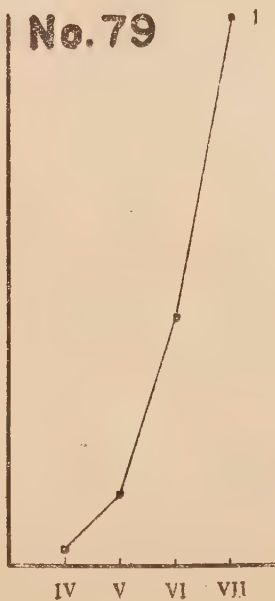
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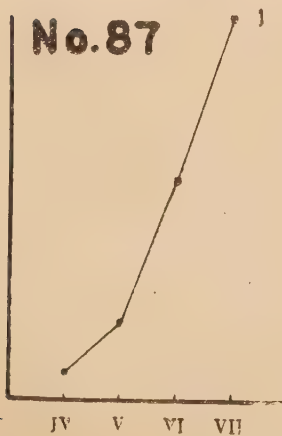
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No.79



No.87



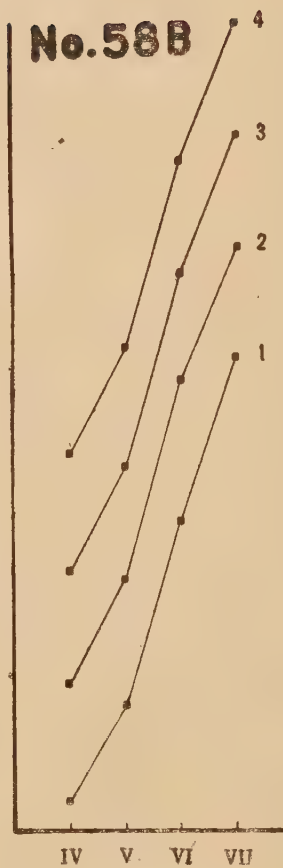
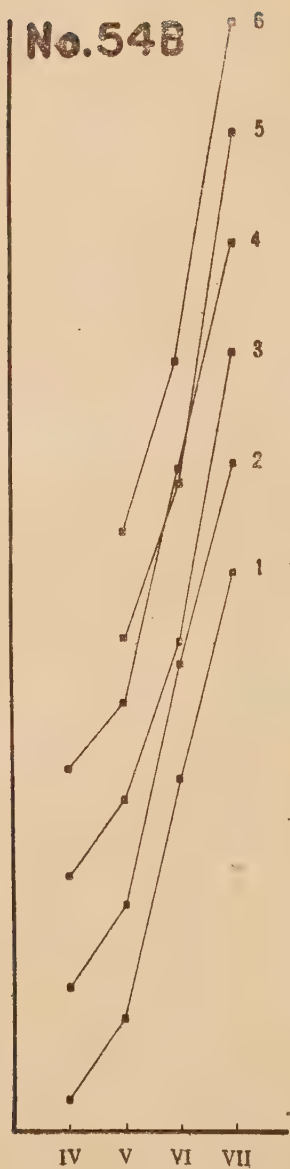


Table 11. Absolute lengths of the regenerate appendages of *Phraortes kumamotoensis* at different instars of growth. Expressed in percentages.

No.	2			3			4			5		13	71
	FT	FF	MT	MF	MT	MF	MT	MF	HT	HF	FT	HF	
I - II											-11.76		
II - III	328.57	400.00			525.00	475.00	125.00	225.00	250.00	250.00	-33.33	-30.43	
III - IV					28.00	134.78	94.44	188.46	185.71	185.71	120.00	18.75	
IV - V					125.00	125.93	122.86	86.67	100.00	100.00	127.27		
V - VI	80.00	20.83	50.00	50.00	150.00	57.38	105.12	42.86	43.75	42.50	82.00		
VI - VII	25.93	53.45	33.33	34.44	54.44	40.63	62.56	35.00			40.66		

No.	6			10			12			22		23	73
	HT	HF	MT	HT	HF	FT	FF	HT	HF	HT	FT	HT	
I - II							-31.58				26.67		
II - III	225.00	250.00	200.00	200.00	240.00		34.62	300.00	300.00		63.16	20.00	
III - IV	53.85	142.86					72.00	190.00	240.00				
IV - V	150.00	102.94				400.00	116.67	141.41	123.53				
V - VI	90.00	44.93	216.67	36.67	76.47	172.00	84.62	64.29	47.37		52.17	33.33	
VI - VII	47.37	40.00	68.42	38.21	42.22	31.97		38.26	36.61				

No.	14		15		17	25		30			33			
	FF	MF	MT	MF		HT	HF	MT	MF	HT	HF	HT	HF	
I - II					-6.67									
II - III	-33.30	400.00	400.00	400.00	-10.71		100.00	250.00	250.00	250.00	233.33	233.33	233.33	233.33
III - IV	90.00	166.67	273.33	300.00	80.00	230.43	300.00				250.00	250.00	250.00	250.00
IV - V	44.74	300.00	185.71	122.22	122.22	97.37	87.50				71.43	64.29	64.29	64.29
V - VI	118.18	87.50	87.50			53.33	53.33	31.25	38.89	48.75	34.83	38.33	39.13	39.13
VI - VII	66.67					30.43	38.26							

No.	37			40			44			47		
	HT	HF	HT	HF	HT	HF	HT	HF	HT	MT	MF	
I - I												
II - III	200.00	200.00	200.00	200.00	120.00	160.00	150.00	150.00	150.00	100.00	80.00	
III - IV	166.67	166.67	166.67	166.67						180.00	255.56	
IV - V	270.00	270.00	225.00	225.00								
V - VI	48.65	48.65	67.69	67.69	75.34	53.06	85.74	53.85	53.85			
VI - VII	45.45	40.91	36.30	34.86						35.11	32.00	

No.	48		45			49		55	
	HT	HF	MT	MF	HT	HF	ET	FF	FF
I - II									
II - III	80.00	80.00	285.71	257.14	257.14	285.71	85.71	85.71	-12.50
III - IV									
IV - V									
V - VI	100.00	60.71	61.62	64.04	77.57	73.20	105.13	143.75	25.00

[illegible]

No.	11		32		34			35		
	FT	FF	HT	HF	FT	FF	MT	MF	HT	HF
III - IV			233.33	266.67	166.67	220.00	233.33	200.00	193.33	250.00
IV - V					320.00	275.00		-11.11	218.18	423.81
V - VI	365.67	290.00			96.43	80.00		75.00	28.57	18.18
VI - VII	100.00	53.85						51.52	20.00	

No.	36						38			56			52		53
	MT	MF	MT	MF	FT	FF	HF	HT	HF	MT	MF	FT			
III - IV	220.00	220.00	233.33	233.33	166.67	193.33	180.00	193.33	206.67	350.00	350.00	316.67			
IV - V	158.33	158.33	164.00	164.00	275.00	286.36	50.00	245.45	226.09			300.00			
V - VI	61.29	61.29	51.52	51.52	64.00	70.59	93.33	63.15	66.67			175.00			
VI - VII	40.00	40.00	43.00	43.00	54.47	35.17	46.55	33.06	32.00						

[illegible]

No.	54 b				55 b		58 b				t	84
	HT	HF	HT	HF	HT	HF	MT	MF	MT	MF		
III - IV												
IV - V	233.33	233.33	286.67	286.67	250.00	210.00	86.67	86.67	86.67	86.67	86.67	20.00
V - VI	252.00	148.00	203.45	203.45	57.14	69.35	78.57	80.36	89.29	85.71	85.71	25.00
VI - VII	71.59	109.68	57.95	57.95				83.66	32.08	42.31	42.31	34.17

No.	59 b						77		79		80		92	
	FT	FF	MT	MF	MT	MF	FT	FF	HT	HF	HT	HF		
III - IV														
IV - V	180.00	204.00	196.00	188.00	246.67	300.00	300.00	26.26	350.00	150.00				
V - VI	251.43	205.26	197.30	177.78	211.54	170.00	240.00	28.00	111.11	88.24	62.50	300.00		
VI - VII					55.56	51.85	120.59	18.75						

No.	82				65				66			
	MT	MF	HT	HF	MT	MF	HT	HF	FT	FF	MT	MF
III - IV					700.00	471.43	500.00	585.71	566.67	780.00	471.43	442.86
IV - V	166.67	186.67	166.67	166.67	250.00	250.00	252.38	200.00	290.00	309.09	290.00	294.74
V - VI	475.00	466.67	300.00	250.00								
VI - VII			75.00	92.86								

No.	67				68				69				85
	HT	HF	HT	HF	HT	HF	FT	FF	HT	HF	t		
III - IV	550.00	600.00	900.00	900.00	500.00	700.00	860.00	785.71	642.86	614.29			
IV - V	246.15		260.00		320.83	217.86	295.83	206.45	265.38	228.00	42.22		
V - VI											17.19		
VI - VII											41.33		
No.	90				91				93				MF
	FF	HT	HF	HT	FF	HT	HF	FF	HT	HF	MT		
III - IV													
IV - V													
V - VI	273.33	500.00	500.00	520.00	1100.00	1900.00	700.00	1500.00	433.33	433.33			
VI - VII													
No.	96				97		98		100		86		
	MT	MF	MT	MF	HT	HF	HT	HF	HT	HF		FT	
III - IV													
IV - V													
V - VI	300.00	300.00	280.00	280.00	400.00	150.00	900.00	1400.00	3700.00	3700.00	100.00		
VI - VII							240.00	246.67					

No.	87	101		102		103		104	
		FT.	FF	FT	FF	MT	MF	MT	MF
III - IV									
IV - V	25.00								
V - VI	60.00	273.33	700.00	600.00	540.00	540.00	352.17	300.00	1140.00
VI - VII	41.67	264.29	192.50					176.67	203.23

In the Table 12 and Text-figures 5-6 are given the values calculated from 127 regenerating appendages which were selected at random among the material. In the first instar when the operation is performed (at the trochantero-femoral suture or groove) δ -value is 100, because no regeneration takes place throughout the instar and the length of the regenerate is zero in value. In the Text-figure 6 I showed 47 different types of the change of δ -value of appendages in many individuals which were operated upon at the beginning of the first instar during the course of the post-embryonic development. Though my method looks like those of KRIZENECKY (1917) who made experiments on *Tenebrio molitor*, the convergency curves of mine are somewhat different from the "Regenerationskurve" of KRIZENECKY and seem to indicate a few interesting facts which are not adequately shown in *Tenebrio molitor*.

The Text-figure 6 shows the distribution of δ -values and further indicates that the convergency quotient in the lengths of appendages is not constant in succeeding instars. In the second instar the δ -value is between 98.15 and 71.42 with an average of *ca.* 90. In the third instar the value fluctuates between 91.89 and 36.36 with an average of *ca.* 75. In the fourth instar the average δ -value is *ca.* 45 with the deviations from 88.23 to 9.09. In the fifth instar the δ -value is between 83.33 and 0.00 with an average of *ca.* 30. In the sixth instar it lies between 73.68 and -5.93 with an average of *ca.* 20. In the last, seventh instar it fluctuates between 28.20 and 10.00 with an average of *ca.* 15. We may be able to divide the change of convergency quotient into three phases which are arranged in a definite order. The first two instars may be regarded as representing the first phase, where the change of the quotient is smaller than those of the second phase. The second phase is consisting of the two following instars and its values are slightly more than those of the third phase, which is represented by the two last instars. In the Text-figure 7 I demonstrated an ideal convergency curve of *Phraortes kumamotoensis* SHIRAKI. The portion G-E of the curve in the figure represents the first phase, E-C the second phase and C-A the first phase of the change of convergency quotient respectively. If the appendage is removed from the trochantero-femoral groove in the sixth instar, the convergency curve between the regenerate

and normal appendage takes the locus G-F, *i.e.* the anterior half of the first phase. If the appendage is removed in the fifth instar, the convergency curve takes the locus G-E, *i.e.* the first phase. If the appendage is removed in the fourth instar, the convergency curve takes the locus G-D, *i.e.* the first phase and the anterior half of the second phase. In case that the appendage is removed in the third instar, the convergency curve takes the locus G-C, *i.e.* the first and second phases. In case that the appendage is amputated in the second instar, the convergency curve falls in the locus G-B, the first and second phases and the anterior half of the third phase. In case that the appendage is operated upon in the first instar, the convergency curve falls in the locus G-A, the first, second and third phases. The absolute length of the radius of curvature of the first phase seems to be slightly larger than that of the third phase, and further features of the former and latter are entirely reverse to each other. Features of the curvature of the anterior and posterior halves of the second phase are also reverse to each other. In the growth of the appendages amputated at any point across the longitudinal axis of the femur and tibia (autotomy-groove is excepted), an ideal convergency curve may be illustrated by a monomodal curve as given in the text-figure. But the real locus of change of convergency quotient along the ideal curve may not be determined so easily as in the case mentioned in the first case. Generally the convergency quotient increases at first and then decreases in value towards the end of the larval stage. For example the change of convergency quotient in the regenerating mid-femur of the insect no. 14 was observed in the following values: 51.61, 70.00, 85.48, 88.88, 73.76, 53.84, 33.33, and those of the regenerating mid-tibia of No. 24 was traced in the following values: 41.09, 53.48, 56.89, 57.33, 27.77, 27.96.

4. Growth-ratios

In order to analyse the characteristics of the growth in length of several regenerates, I applied the formula of relative growth given by HUXLEY to the data, Table 8. Taking the length of the mesonotum as the standard growing organ (x) and the regenerate organs as the differential growing parts (y) up to the adult stage,

No.	25				30				31		32		33		59
	HT(1)	HF	MT(4)	MF(3)	HT(2)	HF(1)	FT	FF	MT(2)	MF(1)	HT	HF	MT(1)		
I		100.00	100.00	100.00	100.00	100.00									
II	100.00	89.79	88.88	88.63	90.19	88.88	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	
III	83.57	86.81	68.75	70.83	74.63	72.22	90.24	91.30	90.00	90.47	92.50	91.42	94.61		
IV	55.80	51.80					78.18	75.83	75.00	72.50	79.79	78.72	91.89		
V	34.78	31.81	11.11	0.00	27.27	11.00	38.70	38.27			42.14	38.05	60.39		
VI	23.33	17.85	4.54	-5.93	8.46	7.69			13.33	16.45	25.00	23.33	20.00		
VII	16.66	11.17					26.53	23.33			17.00	13.51			

No.	34				35				38		40		57 b
	FT(1)	FF(2)	MF(3)	MT(4)	MF(3)	HT(2)	HF(1)	FT	FF	HF	FT(2)	FF(1)	MF
I													
II	100.00	100.00	100.00	100.00	100.00	100.00	100.00				100.00	100.00	
III	90.38	91.17	90.00	88.46	88.46	92.50	91.42	89.28	90.62	90.44	83.07	89.79	
IV	80.76	78.18	77.50	74.11	73.17	79.20	76.92	78.26	79.04	77.01	88.88	82.66	100.00
V	38.68	37.50	85.04	30.00	34.00	16.66		40.47	34.61	73.91	39.16	22.83	75.65
VI	17.50	16.92	81.33	25.00	16.66	20.00	7.14	23.12	17.14	58.57	16.88	9.09	70.58
VII										52.77			

No.	41		42		MT(4)	45			47		FT(1)	79
	MT(2)	MF(1)	HT	HF		MF(3)	HT(2)	HF(1)	MT(2)	MF(1)		
I	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00		
II	88.88	88.88	89.28	88.00	92.70	92.70	94.16	93.00	87.80	88.88		
III	88.70	88.70			79.85	79.16	83.33	80.71	83.87	85.00	100.00	
IV									64.10	58.97	97.50	
V	91.74	92.50			8.33	15.23	17.69	20.49			79.39	
VI					0.00	0.00	2.56	6.66	21.66	20.00	64.27	
VII									14.18	13.72		

No.	48		56		57		62		63		55 b	
	HT(2)	HF(1)	HT(2)	HF(1)	FT(1)	FF	MT	HT(2)	HF(1)	HT	HT	HF
I	100.00	100.00										
II	91.07	90.00	100.00	100.00		40.74	55.55	100.00	100.00			
III	87.50	86.15	89.86	89.28	100.00	70.00	50.00	92.85	92.85	100.00	100.00	
IV			75.55	73.25	96.00	71.96	58.82	77.65	76.74			
V	83.33	50.00	34.48	30.55	90.31	79.72	46.66	37.39	30.27	36.36	40.95	
VI	73.68	37.93	14.48	10.71	88.23	82.02	47.18	15.97	14.70	19.11	22.22	
VII			7.30	13.15								

No.	59 b						80				82		66	
	FT	FF	MT	MF	FT(2)	FF(1)	HT(2)	HF(1)	HT	HF	FT	FF		
I														
II	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
III														
IV					97.36	89.58	80.58	68.75			80.00	79.04		
V	75.00	73.79	63.00	67.27	85.18	76.92	34.78	37.03	82.14	80.38	46.20	37.50		
VI	43.05	44.76	27.63	33.33	56.52	48.64	9.09		46.30	46.96				
VII									22.22	20.58				

No.	68		65				69				73	75
	HT(2)	HF(1)	MT(4)	MF(3)	HT(2)	HF(1)	FT(4)	FF(3)	HT(2)	HF(1)	HT	MT
I												
II	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	59.18	52.00
III	94.28	94.16	95.53	94.16	94.69	94.16	96.42	95.45	95.00	94.16	61.29	61.53
IV	74.73	67.05	72.97	70.00	76.66	70.00	74.44	68.68	73.46	70.58		45.13
V	15.83	19.81	29.29	29.41	33.33	29.41	29.62	25.78	25.78	26.12	70.00	29.07
VI											69.23	

No.	74			75	87	86	88	92			93
	FT(2)	FF(1)	MF					FT	HT	HF	
I	100.00	100.00	60.46	30.95							
II	96.52	96.52	66.10	49.15							
IV	78.12	74.50	75.67	46.83	49.29	50.98	100.00	100.00	100.00	100.00	100.00
V	37.66	37.93	83.17	37.61		41.37	94.44	93.27	91.52	93.18	93.24
VI					34.54	20.08	83.33	91.33	71.42	70.14	71.01
VII					29.16						

No.	91				97	98			101		102	
	FT	FF	HT	HF		HT(2)	HF(1)	FT	FT	FF	FT	FF
IV	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
V	98.07	98.15	97.91	97.92	92.95	97.82	98.18	86.32	96.15	93.37	93.54	
VI	81.25	70.58	86.57	85.72	76.19	79.31	80.00	82.50	75.75	69.56	69.81	
VII					86.18	46.31	39.88	47.44	42.07			

No.	103		104	
	MT	MF	MT(2)	MF(1)
IV	100.00	100.00	100.00	100.00
V	92.06	90.65	92.00	97.50
VI	62.57	68.09	74.57	74.59
VII			42.36	37.37

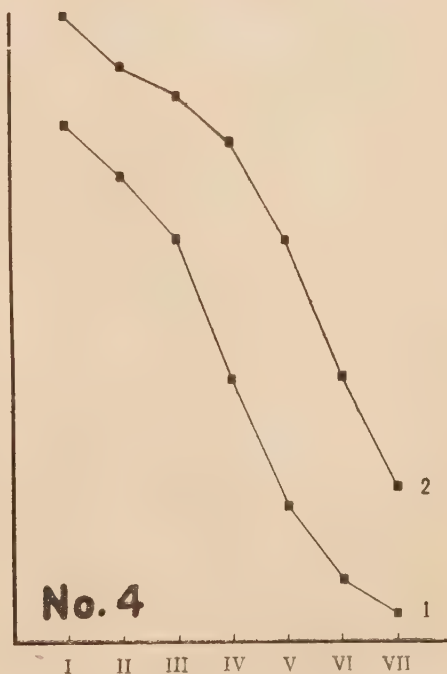
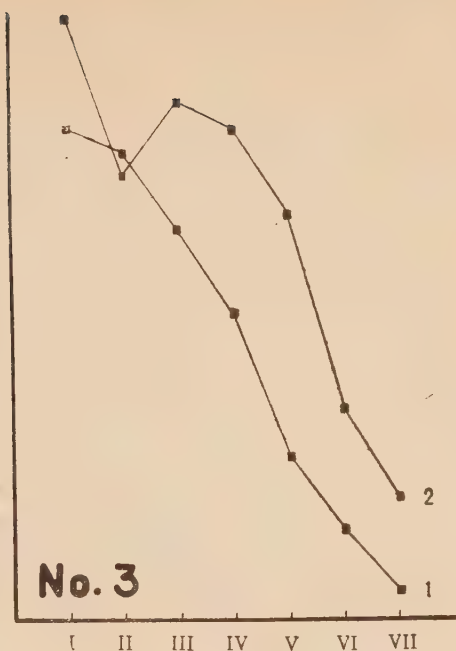
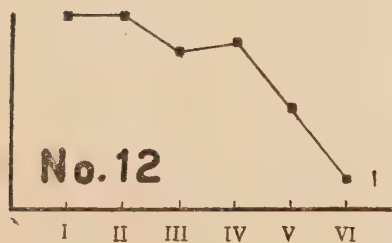
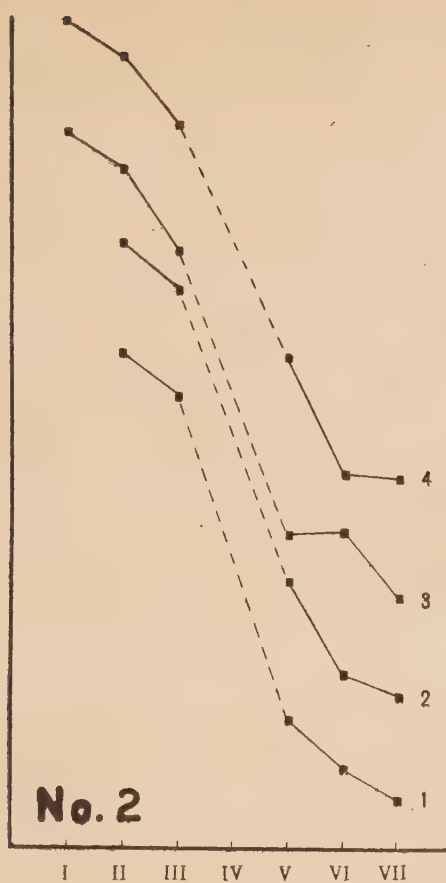
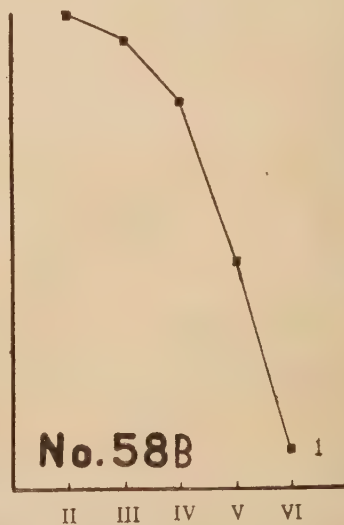
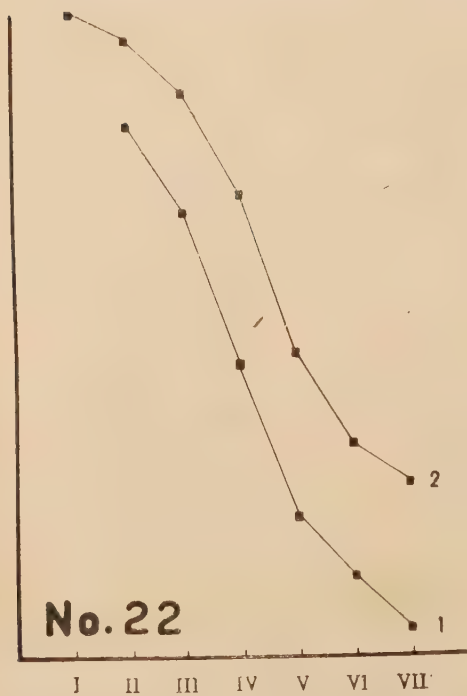
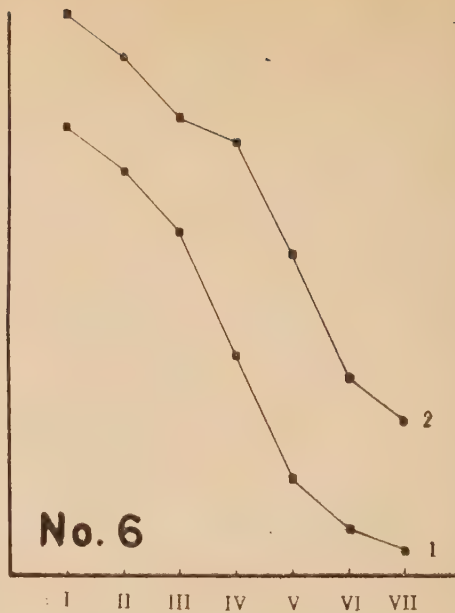
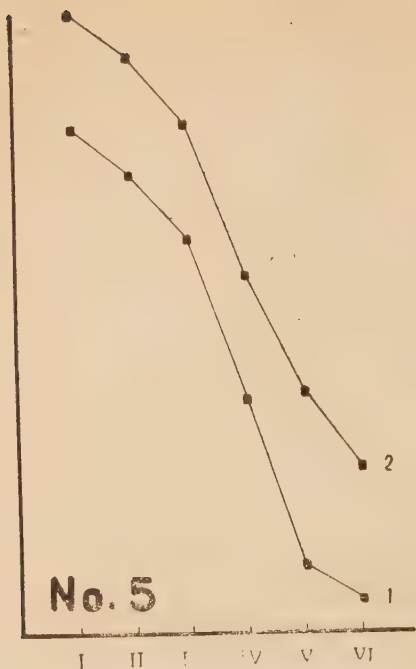
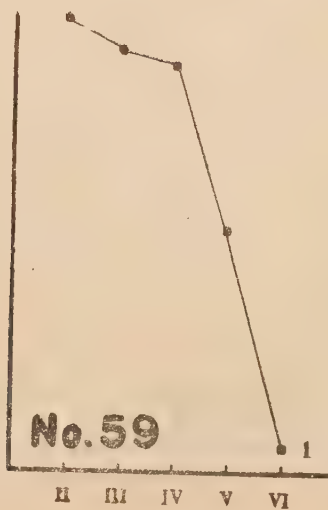
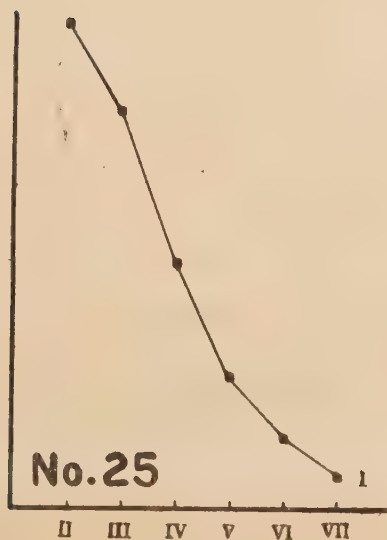
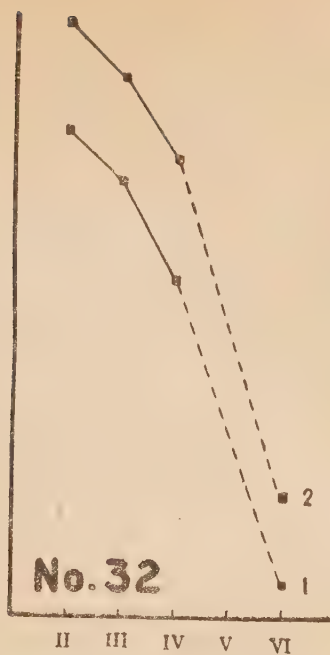
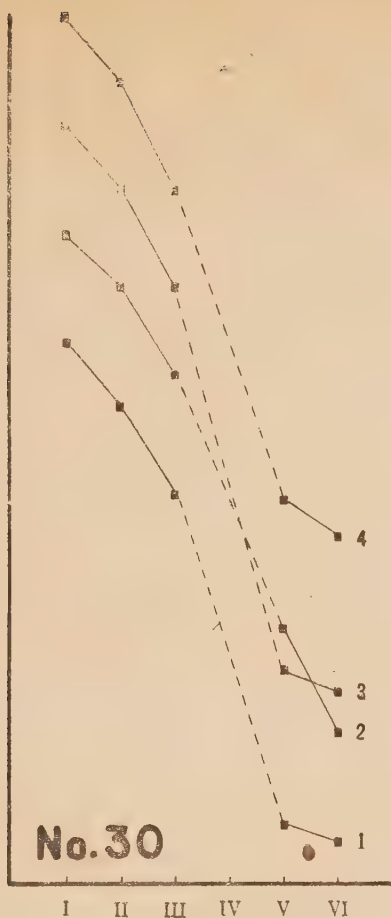
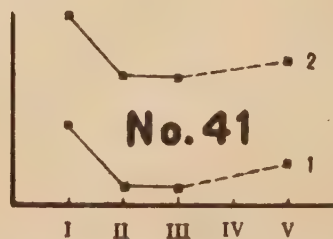
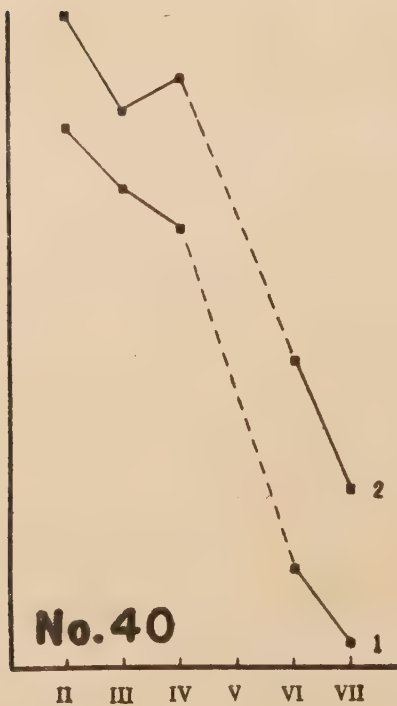
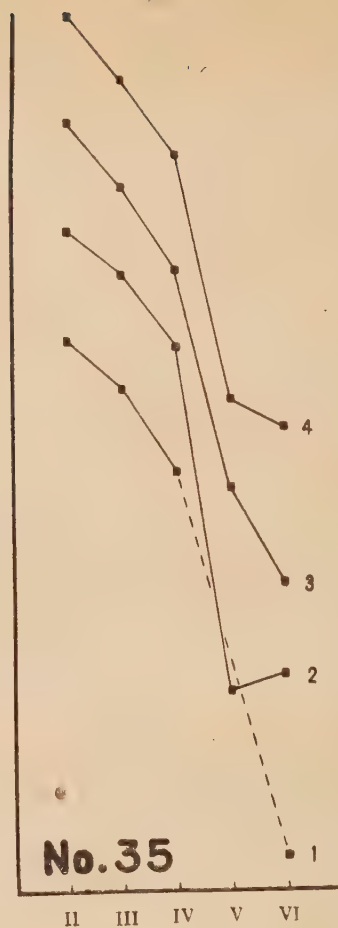
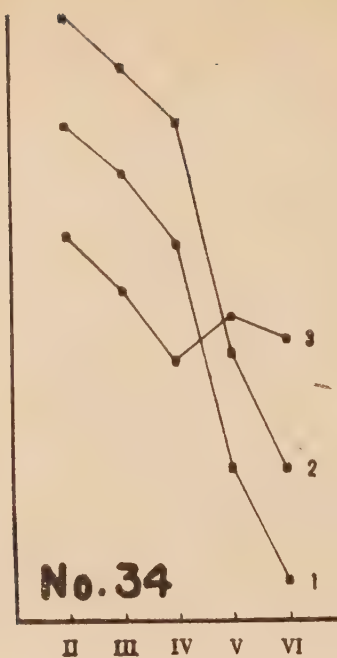
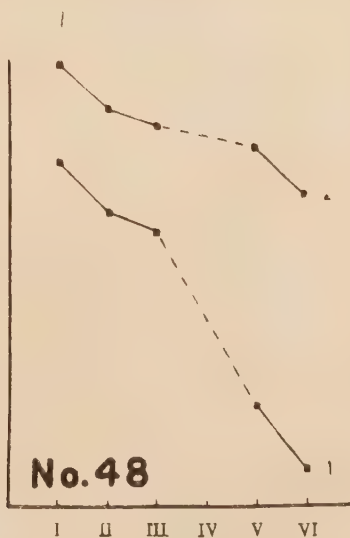
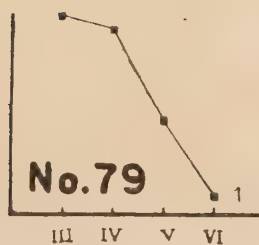
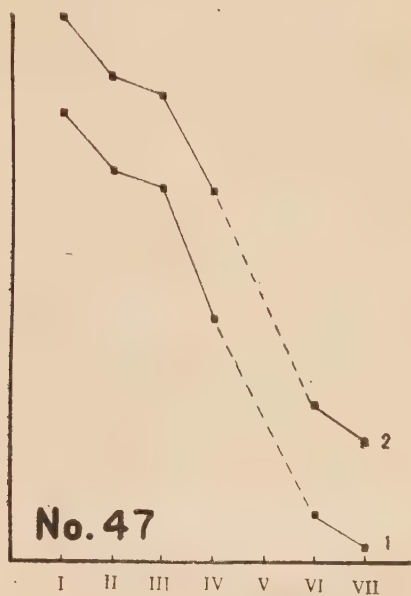
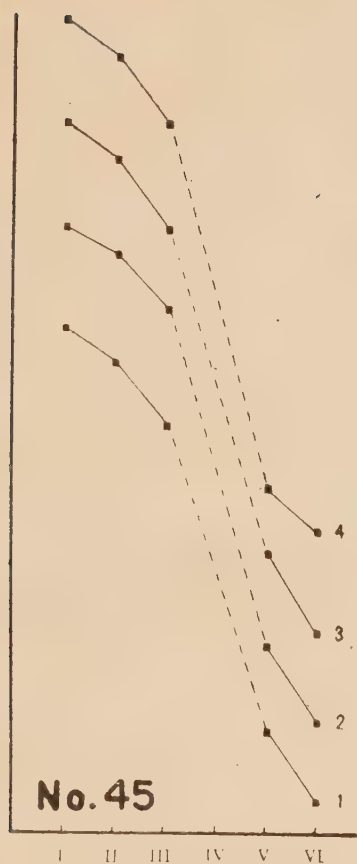


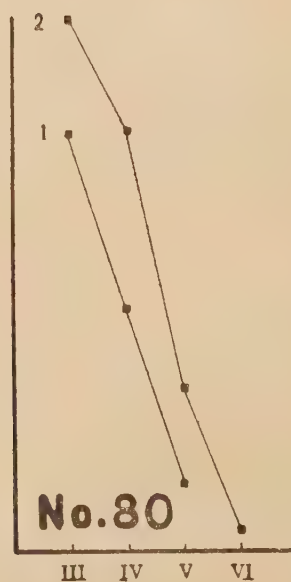
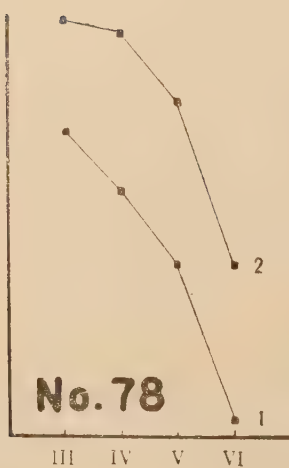
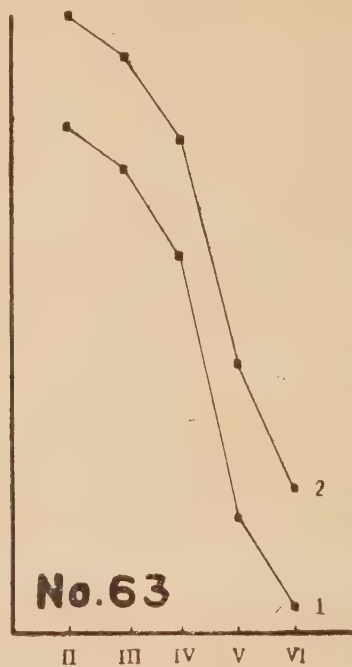
Fig. 5. Recovering in length of regenerating legs of *Phruortes kumamotoensis* at different instars of growth. Abscissa represents the instars.

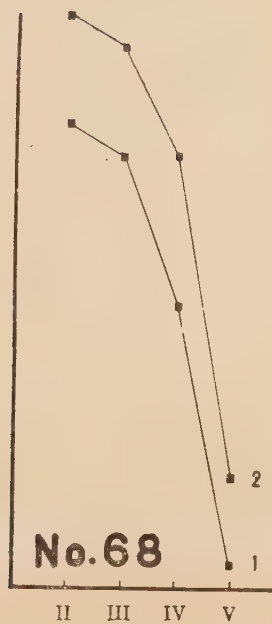
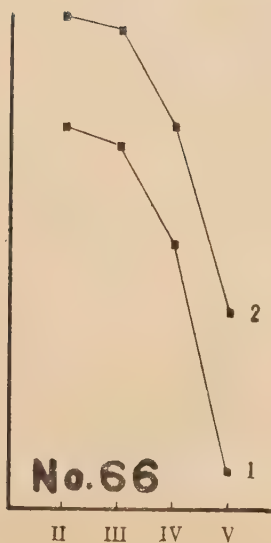
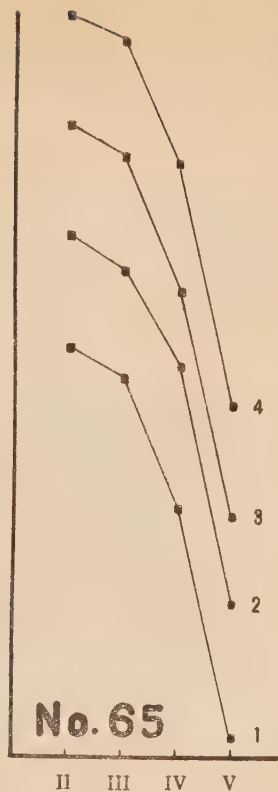
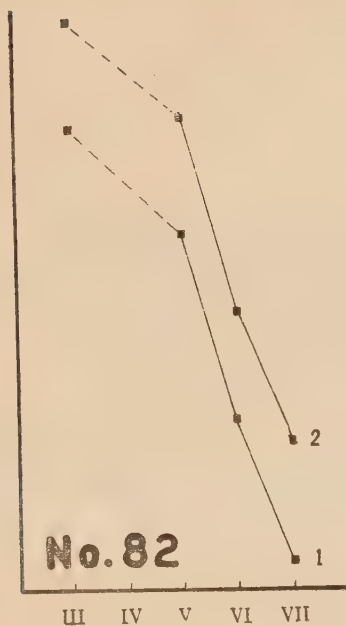
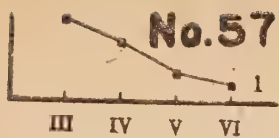


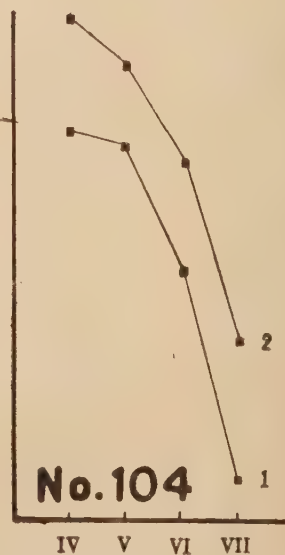
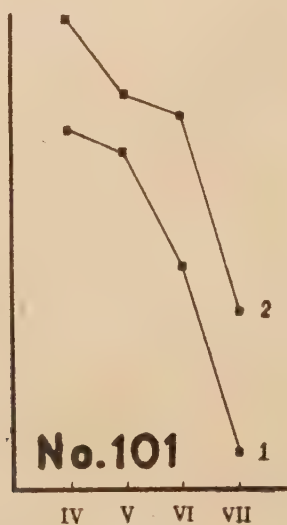
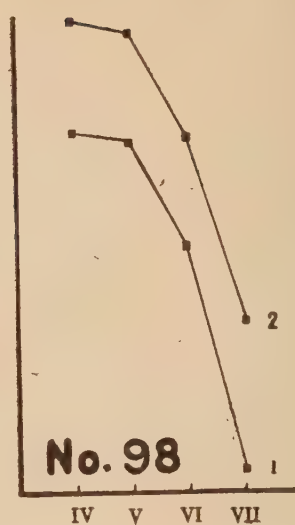
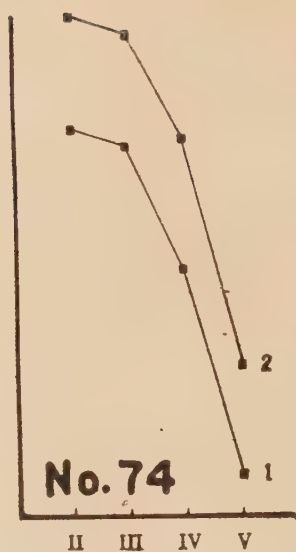












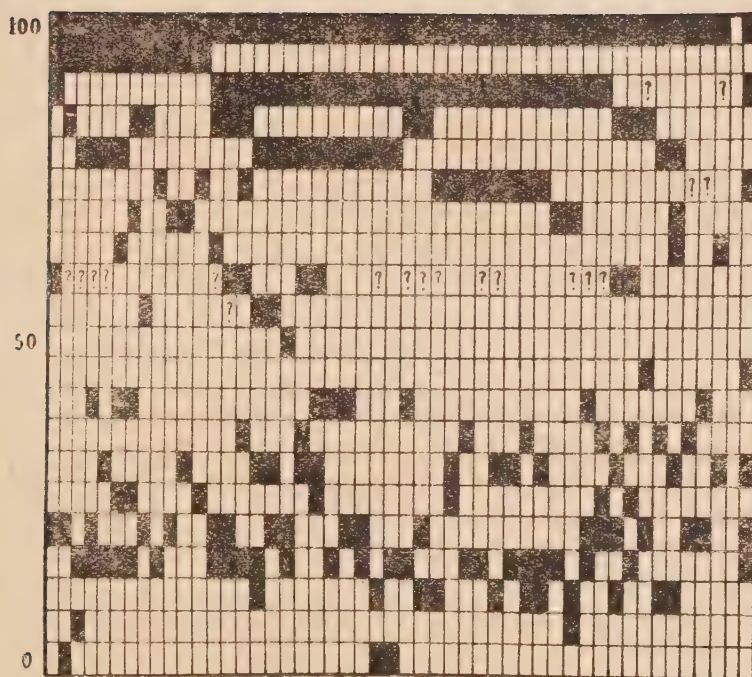


Fig. 6. Forty-seven different types of the change in δ -values of the regenerate appendages of *Phraortes kumamotoensis* at different instars of growth.

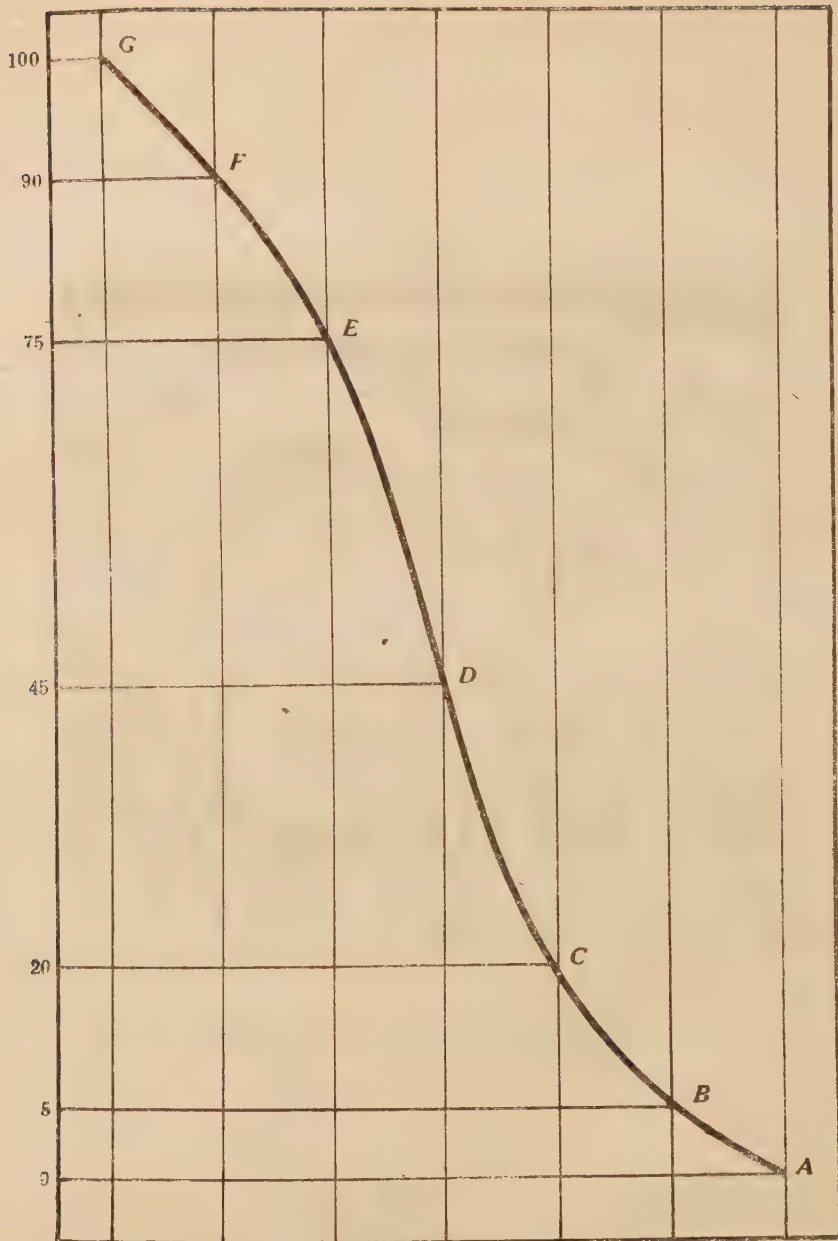


Fig. 7. An idealized convergency curve of *Phraortes kumamotoensis* at different instars of growth.

I secured a series of the so-called growth-ratios for each regenerate. During the process of regeneration the growth-ratios of any of the regenerates are much higher or lower than normal but sooner or later approach the normal value, changing their values at every instar. In other words, regeneration of any allometric organ may not be expressed by a single phase or two, but by several phases in general. For convenience' sake I call an interval (instar) in which a visible appendage first appeared as the second regeneration phase (there is no value of the growth-ratios in the first regeneration phase). The frequency distribution of the growth-ratios of the regenerates (femora and tibiae) in the second regeneration phase is illustrated in the Text-figure 8, where it is shown that the mode of distribution occurs between 6 and 7, and that the majority of the growth ratios are located between 0.0 and 11.7. Further I secured several exceptional cases in which the growth-ratios take the following values respectively: 13.69, 1400, 15.41, 17.11, 17.28, 18.57, 42.00 and 42.66. The frequency distribution of the growth-ratios of the regenerates (femora and tibiae) in the third regeneration phase is demonstrated in the Text-figure 9, where it is shown that the mode of distribution occurs between 4 and 5, and that the majority of the growth-ratios are situated between 0.2 and 9.1. The values 11.3, 11.7, 11.8, 12.00, 13.00 and 16.00 may be exceptional cases. The frequency distribution of the growth-ratios of the regenerates (femora and tibiae) in the fourth regeneration phase is illustrated in the Text-figure 10. In this case it is shown that the mode of distribution lies between 2 and 3, and that the majority of the growth-ratios are located between 0.6 and 9.5. The frequency distribution of the growth-ratios of the regenerates (femora and tibiae) in the fifth regeneration phase is shown in the Text-figure 11 A, where it is clearly demonstrated that the mode of distribution occurs below 2.0, and that the majority of the growth-ratios are located between 0.8 and 5.4. The frequency distribution of the growth-ratios of the regenerates (femora and tibiae) in the last regeneration phase is illustrated in the Text-figure 11 B. In this phase the mode of distribution lies at about 1.5, and the majority of the growth-ratios are seen between 0.5 and 2.3. We are thus driven to suppose that the growth-ratios show generally a marked tendency to reduce the value towards the last regeneration phase and the width of the frequency

distribution of the growth-ratios becomes narrower phase after phase. This conclusion is also supported by the evidence in two other cases. In the first case it can at once be seen that the width of the frequency distribution of the growth-ratios of the regenerate metatarsus becomes narrower phase after phase. The fact is clearly illustrated in the Text-figure 13. The majority of the growth-ratios are located between 0.9 and 7.4. In the third regeneration phase they are situated between 0.4 and 5.0. In the fourth regeneration phase they lie between 0.2 and 3.4. In the next regeneration phase they are located between 0.5 and 2.3. In the second case the same relation may easily be recognizable in the Text-figure 12, in which the case of enantiometry is illustrated. In the second regeneration phase the majority of the growth-ratios of the regenerates (femora and tibiae) are distributed between -0.1 and -7.2 . In the third regeneration phase they are located between -0.3 and -6.5 . In the fourth regeneration phase they are situated between -0.5 and -1.5 . Though data for the growth of the regenerate tarsi (second and the following segments taken together in measurements) are not rich, such a phenomenon as mentioned above may also be detectable. In the second regeneration phase the majority of the growth-ratios are located between 0.5 and 4.5, and in the third regeneration phase they are distributed between 0.3 and 1.1. In the regenerate appendages caused by autotomy the frequency distribution of the growth-ratios of the femora is quite similar to those of the tibiae of the same legs, but those of the tarsi is somewhat different. In the second regeneration phase the distribution width of the growth-ratios of regenerate metatarsi is about two-thirds the widths of regenerate femora or tibiae. In each of the following regeneration phases the distribution width of the growth-ratios of regenerate femora or tibiae is about twice as wide as that of regenerate metatarsi so far as my experiments are concerned.

Table 13. Growth-ratios (α) of the regenerate and normal appendages of *Phraortes kumamotoensis* at different instars of growth.

No. 3		I-II	II-III	III-IV	IV-V	V-VI	VI-VII
Left	F	0.72	1.06	1.50	0.75	0.90	1.10
fore leg	T	0.77	1.00	1.50	1.16	1.09	1.10

Right	F	0.95	1.00	1.25	0.91	0.90	1.10
fore leg	T	0.72	1.00	1.68	1.08	1.09	1.10
Left	F	0.77	1.00	1.37	0.83	1.00	0.90
mid-leg	T	0.68	1.20	1.12	0.91	0.90	1.00
Right	F		5.06	4.91	2.91	1.81	1.50
mid-leg	T		5.26	1.37	2.91	3.63	1.90
Left	F	0.81	1.00	0.87	1.00	1.00	1.10
hind leg	T	0.90	0.80	1.00	1.00	0.72	1.20
Right	F	0.81	1.00	1.00	0.91	1.18	1.00
hind leg	T	0.90	0.86	1.12	0.75	0.90	1.20
Right	1					3.72	1.60
mid-tarsus	2+3+4					1.27	1.10
No. 4		I-II	II-III	III-IV	IV-V	V-VI	VI-VII
Left	F	0.91	0.92	1.85	0.91	1.00	0.89
fore leg	T	0.78	1.15	1.42	1.16	1.22	1.22
Right	F	0.91	0.92	1.55	0.83	1.00	1.22
fore leg	T	1.00	0.92	1.42	1.00	1.33	1.33
Left	F		3.65	6.57	2.59	1.78	1.44
mid-leg	T		2.57	3.28	2.91	3.44	2.33
Right	F	0.74	1.07	1.55	0.83	0.78	1.11
mid-leg	T	0.56	1.07	1.55	0.75	1.22	1.00
Left	F	0.78	0.92	1.42	0.83	1.22	1.22
hind leg	T	0.78	1.15	1.28	0.91	0.77	1.44
Right	F	0.69	1.07	1.42	0.83	1.22	1.22
hind leg	T	0.73	1.21	1.28	0.91	0.77	1.44
Left	1					3.77	2.88
mid-tarsus							
No. 5		I-II	II-III	III-IV	IV-V	V-VI	
Left	F	1.05	0.88	1.83	0.76	0.90	
fore leg	T	0.94	1.05	1.83	0.76	1.30	
Right	F	1.05	0.83	2.00	0.69	1.00	
fore leg	T	0.94	1.05	1.83	0.92	1.10	

Left	F	0.78	0.83	2.00	0.84	0.80
mid-leg	T	1.15	0.66	2.16	0.46	1.10
Right	F	1.00	0.83	2.00	0.61	1.10
mid-leg	T	1.15	0.66	2.00	0.76	0.90
Left	F	0.94	1.05	1.16	0.69	1.30
hind leg	T	0.95	0.72	1.50	1.07	0.80
Right	F		3.00	7.66	2.30	1.50
hind leg	T		3.00	7.66	2.30	1.60
Right	1				1.69	
hind tarsus						

No. 6		I-II	II-III	III-IV	IV-V	V-VI	VI-VII
Left	F	1.15	0.66	1.83	0.92	1.10	1.11
fore leg	T	0.79	1.00	1.33	0.85	1.30	1.33
Right	F	1.00	0.83	1.83	0.92	1.10	1.11
fore leg	T	0.79	1.00	1.33	0.85	1.30	1.33
Left	F	0.73	1.00	1.00	0.92	1.00	0.55
mid-leg	T	0.94	0.83	1.33	0.85	1.00	1.11
Right	F	0.78	1.00	1.00	0.92	1.00	0.55
mid-leg	T	0.94	0.83	0.83	0.85	1.00	1.11
Left	F	1.00	0.94	0.83	0.85	1.00	1.33
hind leg	T	0.78	0.83	1.66	0.78	1.10	1.33
Right	F		4.40	2.16	2.14	1.70	1.55
hind leg	T		5.50	3.33	2.78	2.80	1.88
Right	1					4.00	1.33
hind tarsus	2+3+4					2.80	0.77

No. 7		I-II	II-III	III-IV	IV-V
Antenna	Left	0.85	1.27	1.25	0.93
	Right		6.36	2.50	1.20
Left	F	1.00	1.09	1.16	0.93
fore leg	T	0.95	1.45	1.16	1.00
Right	F	0.75	1.63	1.00	1.06
fore leg	T	0.95	1.36	1.25	1.00

Left	F	0.85	1.27	1.08	0.93
mid-leg	T	1.05	0.90	1.00	1.00
Right	F	0.80	1.27	0.91	0.93
mid-leg	T	0.95	1.18	1.09	1.00
Left	F	1.00	1.18	0.91	0.93
hind leg	T	0.95	1.09	1.00	1.06
Right	F	1.25	0.90	0.91	0.93
hind leg	T	0.90	1.09	1.16	0.93

No. 8		I-II	II-III	III-IV	IV-V	V-VI
Antenna	Left		5.35	3.00	1.46	1.76
	Right	0.89	1.07	1.42	1.00	0.84
Left	F	1.00	1.07	1.42	0.76	1.00
fore leg	T	0.94	1.07	1.57	0.92	0.92
Right	F	0.89	1.07	1.42	0.84	1.00
fore leg	T	1.00	1.00	1.57	1.00	0.84
Left	F	1.05	0.85	1.28	0.92	0.84
mid-leg	T	1.00	0.92	1.57	0.76	0.61
Right	F	0.94	1.00	1.42	0.84	0.84
mid-leg	T	0.94	1.00	1.28	0.92	0.61
Left	F	0.84	1.00	1.14	1.00	0.76
hind leg	T	0.89	1.14	0.57	0.92	0.69
Right	F	1.15	1.00	1.28	0.92	0.76
hind leg	T	1.05	1.07	0.85	0.84	0.69

No. 11		I-II	II-III	III-IV	IV-V	V-VI	VI-VII
Antenna	Right	-1.30	5.50	2.77	1.21	1.90	
Left	F	0.85	1.33	1.11	0.64	1.40	0.88
fore leg	T	0.90	1.33	1.00	0.92	1.30	1.11
Right	F	0.85	1.33			5.90	2.44
fore leg	T	0.80	1.33			6.70	3.33
Left	F	0.90	1.00	1.22	0.64	1.20	1.00
mid-leg	T	1.10	1.00	0.77	1.00	0.90	1.00

Right	F	1.10	1.00	0.77	0.92	1.20	1.00
mid-leg	T	1.10	1.00	0.77	0.92	1.00	1.00
Left	F	0.90	1.00	1.11	0.92	1.10	1.11
hind leg	T	0.90	0.91	1.00	0.78	1.00	1.22
Right	F	0.90	1.25	0.77	0.92	1.10	1.11
hind leg	T	0.80	0.91	0.77	0.92	1.00	1.00
Right	1						2.33
fore tarsus	2+3+4						1.11

No. 12		I-II	II-III	III-IV	IV-V	V-VI
Left	F	0.76	1.31	1.00	1.16	1.25
fore leg	T	0.72	1.12	1.18	1.50	1.50
Right	F	-0.64	0.80	2.09	2.83	2.16
fore leg	T				5.83	3.61
Left	F	0.80	0.87	1.18	0.83	1.66
mid-leg	T	0.68	1.12	0.80	1.08	1.25
Right	F	0.84	1.00	0.90	0.83	1.66
mid-leg	T	0.88	0.87	1.00	1.08	1.25
Left	F	0.88	0.93	1.09	0.91	1.41
hind leg	T	0.76	0.75	1.00	1.16	1.33
Right	F	0.88	0.93	1.09	0.91	1.41
hind leg	T	0.76	0.87	1.00	1.16	1.33

No. 13		I-II	II-III	III-IV	IV-V	V-VI	VI-VII
Left	F	-0.55	-1.54	3.09	2.50	2.60	1.66
fore leg							
Right	F	0.95	1.43	1.09	0.78	1.20	1.11
fore leg	T	0.95	1.54	1.36	0.78	1.20	
Left	F	0.80	1.09	1.19	0.85	1.10	
mid-leg	T	0.90	1.54	0.81	0.85	1.10	
Right	F	0.90	1.09	1.19	0.85	1.10	
mid-lig	T	1.09	1.09	1.00	0.85	0.90	
Left	F	1.00	1.19	1.09	0.78	1.20	
hind leg	T	1.04	1.19	1.72	0.78	1.20	

Right	F	1.04	1.36	1.09	0.78	1.20	
hind leg	T	0.95	1.27	0.81	0.78	1.20	
Left	1					3.00	2.33
fore tarsus							

No. 14		I-II	II-III	III-IV	IV-V	V-VI	VI-VII
Left	F	0.41	1.61	1.11	0.84	1.50	0.75
fore leg	T	0.66	1.46	1.11	0.69	1.37	1.25
Right	F	0.50	1.61	1.11	0.84	1.50	0.75
fore leg	T	0.66	1.46	1.11	0.69	1.37	1.25
Left	F	0.83	0.76	1.22	0.92	1.12	0.75
mid-leg	T	0.75	0.76	1.11	0.92	1.00	0.75
Right	F	0.00	-1.21	3.00	1.23	4.25	2.77
mid-leg							
Left	F	0.75	1.15	0.87	0.84	1.37	0.87
hind leg	T	0.75	1.00	0.55	0.92	1.12	1.00
Right	F	0.75	1.15	0.87	0.92	1.25	1.12
hind leg	T	0.70	1.07	0.77	0.69	1.50	0.87

No. 15		II-III	III-IV	IV-V	V-VI
Left	F	1.19	0.71	1.40	3.20
fore leg	T	1.45	0.78	1.80	3.40
Left	F	6.36	4.07	4.60	5.40
mid-leg	T	6.36	3.07	6.00	5.40
Right	F	0.72	1.21	1.20	3.40
mid-leg	T	1.09	0.92	1.20	3.80
Left	F	1.18	0.85	1.20	3.00
hind leg	T	1.45	0.71	1.40	3.20
Right	F	1.63	0.85	1.20	
hind leg	T	1.27	0.71	1.40	

No. 19		I-II	II-III	III-IV	IV-V	V-VI
Antenna	Left	0.55	1.90	1.81	1.53	1.27
	Right	0.66	1.50	1.00	0.92	1.18

Left	F	0.62	1.30	1.27	0.76	0.81
fore leg	T	0.62	1.40	1.18	1.00	0.90
Right	F	0.62	1.30	1.09	0.69	1.09
fore leg	T	0.62	1.40	1.18	0.84	1.09
Left	F	0.70	1.40	0.72	0.76	1.09
mid-leg	T	0.81	1.40	0.72	1.00	0.81
Right	F	0.85	1.00	1.00	0.76	1.09
mid-leg	T	0.81	1.20	0.90	1.00	0.81
Left	F	0.62	1.30	1.00	0.76	1.09
hind leg	T	0.73	1.20	0.81	0.76	1.09
Right	F	0.59	1.50	0.90	0.84	1.09
hind leg	T	0.59	1.18	0.90	0.69	1.09

No. 22		I-II	II-III	III-IV	IV-V	V-VI	VI-VII
Left	F	1.22	0.92	1.66	1.07	0.90	0.81
fore leg	T	0.90	1.07	2.16	0.92	1.00	1.27
Right	F	0.90	1.00	1.50	1.07	0.90	0.81
fore leg	T	0.59	1.07	2.00	1.00	1.00	1.27
Left	F	0.85	*0.84	1.66	1.00	1.00	0.81
mid-leg	T	0.85	0.92	2.00	0.84	1.09	0.81
Right	F	0.85	0.84	1.66	1.00	1.00	0.81
mid-leg	T	0.81	0.92	2.00	0.84	1.09	0.63
Left	F		2.77	8.83	2.69	1.45	1.27
hind leg	T		2.77	7.66	2.92	2.00	1.27
Right	F	0.77	0.92	1.50	1.00	1.00	0.81
hind leg	T	0.70	1.09	1.83	1.82	1.00	0.90
Left	I					2.72	1.18
hind tarsus	2+3+4					2.18	0.27

No. 24		I-II	II-III	III-IV	IV-V	V-VI
Left	F	0.81	1.75	1.00	0.90	0.71
fore leg	T	0.90	1.75	0.58	1.45	0.78

Right	F	0.77	1.75	1.00	0.90	0.71
fore leg	T	0.81	1.75	0.58	1.45	0.78
Left	F	0.72	1.62	0.91	0.72	0.92
mid-leg	T	0.86	1.62	0.91	0.72	0.85
Right	F	0.86	1.25	0.91	1.00	0.64
mid-leg	T	0.45	1.12	0.91	2.81	0.78
Left	F	0.86	1.25	1.08	1.00	0.71
hind leg	T	0.90	1.12	0.75	1.09	0.71
Right	F	1.00	1.25	1.08	1.00	0.71
hind leg	T	0.68	1.75	0.75	1.09	0.71
Right	1					1.21
mid-tarsus	2+3+4					1.2

No. 25		II-III	III-IV	IV-V	V-VI	VI-VII
Left	F	1.18	1.10	1.08	1.09	1.00
fore leg	T	1.36	1.10	1.00	1.18	1.42
Right	F	1.36	1.10	1.08	1.09	1.00
fore leg	T	1.27	1.30	0.83	1.18	1.42
Left	F	0.81	1.20	1.00	1.45	0.85
mid-leg	T	0.72	0.80	1.00	1.09	1.14
Right	F	1.00	1.20	0.58	1.45	0.85
mid-leg	T	1.09	0.80	1.00	1.09	1.14
Left	F	1.27	0.80	1.08	0.90	1.57
hind leg	T	1.00	0.90	1.08	1.00	1.14
Right	F	2.81	6.00	2.25	1.72	2.00
hind leg	T	3.36	5.10	2.50	1.72	1.57
Right	1				1.36	0.85
hind tarsus	2+3+4				0.90	0.00

No. 33		III-IV	IV-V	V-VI	VI-VII
Left	F	1.27	0.72	1.10	1.00
fore leg	T	1.36	0.90	1.30	1.22
Right	F	1.27	0.72	1.10	1.00
fore leg	T	1.36	0.90	1.30	1.22

Left	F	1.18	0.90	1.10	0.77
mid-leg	T	0.90	0.90	1.30	0.77
Right	F	1.18	0.90	1.10	0.77
mid-leg	T	1.00	0.90	1.30	0.77
Left	F	4.81	4.90	2.40	1.33
hind leg	T	4.81	4.90	2.30	1.36
Right	F	1.18	0.72	1.20	1.00
hind leg	T	0.81	0.81	1.20	1.11
Left	1				1.00
hind tarsus	2+3+4				0.77

No. 34		II-III	III-IV	IV-V	V-VI
Left	F	1.06	1.20	0.84	1.40
fore leg	T	1.33	1.20	0.92	1.70
Right	F		5.10	4.38	2.50
fore leg	T		4.30	4.76	2.90
Left	F		4.80	-0.38	2.40
mid-leg	T		5.30		
Right	F	0.86	1.30	0.92	1.50
mid-leg	T	0.93	1.10	0.92	1.60
Left	F	1.00	1.30	0.76	1.70
hind leg	T	0.93	1.30	0.92	1.70
Right	F	1.00	1.30	0.76	1.70
hind leg	T	0.93	1.30	0.92	1.70

No. 35		II-III	III-IV	IV-V	V-VI
Left	F	0.93	1.27	1.16	1.28
fore leg	T	1.33	1.18	0.83	1.57
Right	F	0.93	1.27	1.16	1.28
fore leg	T	1.33	1.18	0.83	1.57
Left	F	1.06	0.90	1.50	1.00
mid-leg	T	1.06	1.00	1.33	1.00
Right	F		4.27	7.83	2.71
mid-leg	T		4.27	8.33	1.57

Left	F		5.00	12.00	1.00
hind leg	T		5.00	11.33	1.00
Right	F	0.86	1.00	1.50	1.42
hind leg	T	0.86	0.90	1.16	1.42

No. 36		II-III	III-IV	IV-V	V-VI	VI-VII
Left	F	1.61			4.75	4.00
fore leg	T	1.09			4.75	
Right	F	1.61	0.81	1.75	1.00	1.28
fore leg	T	1.09	1.45	0.91	1.33	1.14
Left	F		4.72	3.50	1.58	2.14
mid-leg	T		4.63	3.41	1.75	2.00
Right	F		4.72	3.50	1.58	2.14
mid-leg	T		4.64	3.41	1.75	2.00
Left	F	1.15	1.09	0.83	0.05	1.57
hind leg	T	0.92		-1.41	2.91	5.00
Right	F	1.15	1.09	1.00	0.83	1.42
hind leg	T	0.92	0.72	0.91	0.91	1.42
Right	1					0.85
mid-tarsus	2+3+4					0.57

No. 37		III-IV	IV-V	V-VI	VI-VII
Left	F	1.20	0.90	0.58	1.37
fore leg	T	1.50	0.63	1.08	1.50
Right	F	1.20	0.90	0.58	1.37
fore leg	T	1.50	0.63	1.08	1.50
Left	F	1.00	0.80	0.83	1.00
mid-leg	T	1.30	0.90	0.66	1.12
Right	F	1.00	0.80	0.83	1.00
mid-leg	T	1.30	0.90	0.66	1.12
Left	F	4.50	5.09	1.50	2.00
hind leg	T	4.50	4.63	1.83	1.75
Right	F	4.50	5.09	1.50	1.87
hind leg	T	4.50	4.63	1.83	1.62
Right	1				1.12
hind tarsus	2+3+4				0.50

No. 38		III-IV	IV-V	V-VI	VI-VII
Left	F	1.20	0.75	1.30	
fore leg	T	1.20	1.16	1.00	
Right	F	4.70	4.83	2.40	1.30
fore leg	T	4.30	6.06	2.10	1.90
Left	F	1.30	0.83	0.90	1.00
mid-leg	T	1.30	0.58	1.00	1.00
Right	F	1.30	0.83	0.90	1.00
mid-leg	T	1.30	0.58	1.00	1.00
Left	F	2.60	2.83	2.90	1.60
hind leg	T	4.00			
Right	F	1.00	1.08	0.80	1.10
hind leg	T	1.30	0.75	1.10	1.00
Right	1				1.60
fore tarsus	2+3+4				0.60

No. 39		II-III	III-IV	IV-V	V-VI
Antenna	Left	1.00	1.62	1.14	1.60
	Right	1.46	2.25	2.50	2.70
Left	F	1.06	1.25	1.08	1.40
fore leg	T	1.13	1.75	1.08	2.00
Right	F	1.06	1.25	1.16	1.30
fore leg	T	1.13	1.75	1.08	2.00
Left	F	0.93	1.12	1.16	1.50
mid-leg	T	0.93	1.25	0.91	1.80
Right	F	0.93	1.12	1.16	1.50
mid-leg	T	0.73	1.62	0.91	1.80
Left	F	1.00	1.37	1.16	1.50
hind leg	T	1.06	1.25	1.08	1.50
Right	F	0.93	1.37	1.16	1.50
hind leg	T	1.06	1.25	1.08	1.50

No. 50		I-II	II-III	III-VI	IV-V
Antenna	Left	0.94	0.83	1.50	1.00
	Right	1.00	1.83	2.30	1.41
Left	F	1.11	0.91	1.20	
fore leg	T	0.83	1.25	1.10	1.00
Right	F	1.22	0.91	1.20	
fore leg	T	0.83	1.25	1.10	1.00
Left	F	1.00	0.91	1.10	0.75
mid-leg	T	1.00	1.00	1.20	0.75
Right	F	1.00	0.91	1.10	0.75
mid-leg	T	1.00	1.00	1.20	0.75
Left	F	0.83	1.00	1.10	0.91
hind leg	T	0.66	1.25	1.30	0.75
Right	F	0.83	1.00	1.10	0.91
hind leg	T	1.00	0.75	1.30	0.75

No. 77		IV-V	V-VI	VI-VII
Left	F	1.08	0.90	0.83
fore leg	T	1.16	1.10	1.44
Right	F	1.08	0.90	0.88
fore leg	T	1.16	1.10	1.44
Right	F	5.00	4.30	2.00
mid-leg	T	4.50	4.90	2.22
Left	F	1.16	0.90	1.11
hind leg	T	0.83	1.10	1.22
Right	F	1.16	0.90	1.11
hind leg	T	0.83	1.10	1.22
Right	1			1.77
mid-tarsus	2+3+4			0.66

No. 55		II-III	III-IV	IV-V	V-VI
Left	F	1.07	0.90	1.25	1.62
fore leg	T	1.21	1.18	1.33	2.37

Right	F	1.07	0.90	1.16	1.75	
fore leg	T	1.14	1.27	1.33	2.37	
Left	F	0.92	0.90	1.33	1.75	
mid-leg	T	1.14	0.36	1.25	2.25	
Right	F	0.42	-1.54	0.83		
mid-leg	T		1.72			
Left	F	1.14	1.00	1.16	1.87	
hind leg	T	0.93	0.90	1.08	2.50	
Right	F	1.07	1.09	1.16	1.87	
hind leg	T	0.93	0.90	1.08	2.50	
No. 56		II-III	III-IV	IV-V	V-VI	VI-VII
Left	F	1.42	0.93	0.92	0.81	1.00
fore leg	T	2.57	0.68	1.07	1.00	1.22
Right	F	1.42	0.93	0.92	0.81	1.22
fore leg	T	2.71	0.50	1.07	1.00	1.22
Left	F	2.00	0.62	1.00	2.36	
mid-leg	T	1.57	0.62	0.84	1.09	1.11
Right	F	2.28	0.50	1.00	2.36	
mid-leg	T	2.28	0.50	0.84	1.09	1.00
Left	F		2.43	4.00	1.90	1.33
hind leg	T		2.35	4.15	1.90	1.33
Right	F	2.14	0.56	0.76	1.00	1.55
hind leg	T	2.28	0.56	0.84	0.90	1.00
Left	1				1.90	1.00
hind tarsus	2+3+4				1.54	0.44
No. 57		II-III	III-IV	IV-V	V-VI	
Left	F	-0.80	0.90	0.00	0.30	
fore leg	T			3.76	2.10	
Right	F	1.13	1.30	1.07	0.80	
fore leg	T	1.66	1.50	0.84	1.20	
Left	F	0.93	1.70	0.54	0.90	
mid-leg	T	0.80	1.30	0.76	1.10	

Right	F	0.86	1.70	0.54	0.90
mid-leg	T	0.86	1.30	0.76	1.10
Left	F	1.00	1.20	0.84	1.00
hind leg	T	1.13	0.90	0.92	0.90
Right	F	1.00	1.20	0.84	1.00
hind leg	T	0.93	0.90	0.92	0.90
No. 58		II-III	III-IV	IV-V	V-VI
Left	F	1.36	1.11	1.15	2.80
fore leg	T	1.63	1.22	1.07	3.80
Right	F	1.27	0.66	1.15	3.20
fore leg	T		5.63	4.61	8.80
Left	F	1.45	1.44	1.00	3.20
mid-leg	T	1.27	1.00	0.92	4.00
Right	F	1.54	1.33	1.00	3.20
mid-leg	T		1.22	0.92	4.80
Left	F	1.36	1.11	1.15	3.33
hind leg	T	1.18	0.55	1.15	4.00
Right	F	1.36	1.11	1.53	2.80
hind leg	T	1.45	1.11	1.07	2.60
Right	1			-1.30	9.20
mid-tarsus	2+3+4			1.00	4.00
No. 59		II-III	III-VI	VI-V	V-VI
Left	F	1.00	0.83	1.08	2.71
fore leg	T	0.93	1.33	1.00	3.14
Right	F	1.00	0.83	1.08	2.71
fore leg	T	0.93	1.33	1.00	3.14
Left	F	0.93	0.91	1.00	2.42
mid-leg	T	1.06	0.41	1.16	2.42
Right	F	0.62	0.83	0.75	3.42
mid-leg	T		1.91	6.91	6.71
Left	F	1.12	1.08	0.75	3.14
hind leg	T	0.68	1.00	0.91	2.71

Right	F	0.81	1.08	0.75	3.14
hind leg	T	0.93	1.00	0.91	2.71
Right	1				5.71
mid-tarsus	2+3+4				1.85
No. 62		II-III	III-VI	IV-V	V-VI
Left	F	1.06	1.50	1.00	0.90
fore leg	T	1.33	1.37	1.13	1.30
Right	F	1.06	1.50	1.00	0.90
fore leg	T	1.33	1.37	1.13	1.30
Left	F	1.00	1.62	0.86	1.40
mid-leg	T	0.80	1.87	0.66	1.30
Right	F	1.13	1.50	0.73	0.70
mid-leg	T	1.13	0.87	1.33	1.30
Left	F	1.00	1.50	1.00	1.20
hind leg	T	0.66	2.62	0.80	1.40
Right	F	0.93	1.62	1.00	1.20
hind leg	T	1.00	1.87	0.86	1.10
No. 63		II-III	III-IV	IV-V	V-VI
Left	F	0.80	1.09	1.12	1.37
fore leg	T	1.00	1.36	1.00	1.25
Right	F	0.73	1.09	1.12	1.12
fore leg	T	1.00	1.18	0.87	1.25
Left	F	0.73	1.18	0.87	1.25
mid-leg	T	0.53	0.90	1.50	0.62
Right	F	1.00	1.18	0.87	1.12
mid-leg	T	0.80	0.90	1.50	0.62
Left	F	1.06	0.81	1.37	1.12
hind leg	T	0.86	1.18	1.12	1.25
Right	F		5.72	7.25	2.25
hind leg	T		5.72	6.62	2.87
Right	1				2.00
hind tarsus	2+3+4				1.00

No. 49		I-II	II-III	III-IV	IV-V
Antenna	Left			5.61	1.41
Left	F		3.37	5.30	3.25
fore leg	T		3.37	6.00	2.58
Left	F	0.69	1.75	0.84	1.41
mid-leg	T	0.61	1.75	0.76	1.08
Right	F	0.69	1.75	0.84	1.41
mid-leg	T	0.57	1.87	0.76	1.08
Left	F	0.84	1.25	0.92	1.08
hind leg	T	0.57	1.87	0.84	1.08
Right	F	0.80	1.37	0.92	1.08
mid-leg	T	0.57	1.87	0.84	1.08
Left	1				2.70
fore tarsus	2+3+4				1.83

No. 65b		II-III	III-IV	IV-V
Left	F	1.06	1.00	1.30
fore leg	T	1.06	1.16	1.20
Right	F	1.06	1.00	1.30
fore leg	T	1.06	1.16	1.20
Left	F		6.50	5.20
mid-leg	T		7.75	5.20
Right	F	0.80	0.83	1.10
mid-leg	T	0.80	1.00	1.30
Left	F	1.00	1.08	1.00
hind leg	T	0.80	1.16	0.90
Right	F		7.00	4.70
hind leg	T		6.50	5.40
Left	1			3.00
mid-tarsus	2+3+4			4.50
Right	1			5.80
hind tarsus	2+3+4			4.00

No. 66		II-III	III-IV	IV-V
Left	F	1.44	1.00	1.08
fore leg	T	1.66	1.06	1.33
Right	F		6.33	5.08
fore leg	T		9.22	4.91
Left	F		4.20	5.00
mid-leg	T		5.00	3.50
Right	F	1.55	0.86	1.08
mid-leg	T	1.88	0.80	1.08
Left	F	1.11	1.06	1.00
hind leg	T	0.91		0.75
Right	F	1.33	1.20	1.00
hind leg	T	1.66	0.53	1.58

No. 68		II-III	III-IV	IV-V
Left	F	1.27	1.14	0.85
fore leg	T	1.45	0.92	1.21
Right	F	1.27	1.14	0.85
fore leg	T	1.45	0.92	1.21
Left	F	1.27	1.00	0.92
mid-leg	T	1.45	0.78	0.92
Right	F	1.27	1.00	0.92
mid-leg	T	1.45	0.78	0.92
Left	F	1.09	1.07	9.85
hind leg	T	1.36	0.92	0.71
Right	F		6.42	3.57
hind leg	T		5.57	4.42
Right	1			3.07
hind tarsus	2+3+4			2.14

No. 69		II-III	III-IV	IV-V
Left	F		7.30	3.00
fore leg	T		7.61	3.68

Right	F	1.90	0.84	0.68
fore leg	T	1.90	1.00	1.00
Left	F	1.40	0.84	0.93
mid-leg	T	1.40	0.84	0.93
Right	F	1.40	0.84	0.93
mid-leg	T	1.40	0.84	0.93
Left	F	1.10	1.15	0.75
hind leg	T	1.50	1.15	0.68
Right	F		6.38	3.25
hind leg	T		6.69	3.50

No. 71		II-III	III-IV	IV-V
Left	F	1.08	1.15	1.07
fore leg	T	1.41	1.23	1.14
Right	F	1.25	1.00	1.07
fore leg	T	1.50	0.84	1.14
Left	F	0.75	0.84	1.28
mid-leg	T	1.41	1.00	0.85
Right	F	1.08	0.84	1.28
mid-leg	T	1.08	2.00	0.85
Left	F	1.33	1.00	1.14
hind leg	T	0.83	0.84	1.14
Right	F	-1.33	0.53	
hind leg				

No. 74		II-III	III-IV	IV-V
Left	F	1.20	1.36	1.14
fore leg	T	1.60	1.18	1.28
Right	F		9.27	3.92
fore leg	T		8.45	4.50
Left	F	0.70	-0.45	0.00
mid-leg				
Right	F	1.40	0.81	1.21
mid-leg	T	1.40	1.18	1.00

Left	F	1.30	1.27	0.85
hind leg	T	1.10	1.09	1.14
Right	F	1.30	1.27	0.85
hind leg	T	1.10	1.09	1.14
No. 75		II-III	III-IV	IV-V
Left	F	1.06	1.30	1.00
fore leg	T	1.00	1.40	1.00
Right	F	1.06	1.30	1.00
fore leg	T	1.00	1.40	1.00
Left	F	1.13	0.70	1.33
mid-leg	T	1.00	1.20	0.93
Right	F	0.93	1.00	0.86
mid-leg	T	0.06	1.50	1.40
Left	F	1.00	1.40	0.86
hind leg	T	0.73	1.20	0.80
Right	F	0.86	1.40	0.86
hind leg	T	0.73	1.50	0.80
No. 76		II-III	III-IV	IV-V
Left	F	0.86	1.22	1.37
fore leg	T	0.80	1.33	1.12
Right	F	0.86	1.22	1.00
fore leg	T	0.06	2.22	2.62
Left	F	0.73	1.22	1.37
mid-leg	T	0.93	1.05	1.25
Right	F	0.73	1.22	1.37
mid-leg	T	0.93	1.05	1.25
Left	F	0.86	1.25	1.37
hind leg	T	0.66	1.16	0.87
Right	F	0.86	1.25	1.37
hind leg	T	0.66	1.16	0.87
Right	1			3.75
fore tarsus	2+3+4			1.12

No. 78		IV-V	V-VI
Right	F	1.00	1.66
fore leg	T	1.23	1.44
Left	F	3.61	5.55
fore leg	T	8.07	5.66
Left	F	1.00	1.55
mid-leg	T	1.07	1.77
Right	F	1.15	1.55
mid-leg	T	1.23	1.77
Left	F	1.15	1.88
hind leg	T	1.07	
Right	F	1.00	1.88
hind leg	T	1.23	
Left	1		6.66
fore tarsus	2+3+4		2.55

No. 79		IV-V	V-VI	VI-VII
Left	F	1.00	1.09	1.16
fore leg	T	0.91	0.90	1.83
Right	F	1.00	1.00	1.16
fore leg	T	5.08	4.81	5.69
Left	F	0.83	1.00	1.33
mid-leg	T	0.83	1.00	1.33
Right	F	0.83	1.00	1.33
mid-leg	T	0.83	1.00	1.50
Left	F	0.91	1.00	1.00
hind leg	T	0.58	1.19	1.33
Right	F	0.91	1.00	1.33
hind leg	T	0.58	1.19	1.50

No. 80		III-IV	IV-V	V-VI
Left	F	1.08	1.25	1.30
fore leg	T	1.25	1.33	1.90

Right	F	1.08	1.25	1.30
fore leg	T	1.25	1.33	1.90
Left	F	0.83	1.33	1.30
mid-leg	T	1.33	0.75	1.90
Right	F	0.83	1.33	1.30
mid-leg	T	1.33	0.75	1.90
Left	F	1.08	1.25	1.40
hind leg	T	1.08	1.08	1.80
Right	F		3.75	2.80
hind leg	T		5.41	3.20
Right	1			5.30
fore tarsus	2+3+4			1.70
No. 87		IV-V	V-VI	VI-VII
Left	F	1.00	0.92	1.00
fore leg	T	0.66	1.15	1.22
Right	F	1.00	0.92	1.00
fore leg	T	0.66	1.15	1.22
Left	F	0.58	1.46	0.77
mid-leg	T	0.83	1.53	1.66
Right	F	0.83	1.23	0.66
mid-leg	T		3.00	1.22
Left	F	1.00	0.92	1.11
hind leg	T	0.25	1.38	1.33
Right	F	1.00	0.92	1.11
hind leg	T	0.50	1.00	1.33
Right	1		2.38	2.22
mid-tarsus	2+3+4		3.07	0.88
No. 101		IV-V	V-VI	VI-VII
Left	F		11.37	4.60
fore leg	T		7.12	5.60
Right	F	0.76	1.25	0.90
fore leg	T	1.00	1.25	0.90

Left	F	0.69	1.75	0.60
mid-leg	T	0.84	1.50	0.70
Right	F	0.69	1.75	0.60
mid-leg	T	0.69	1.50	0.90
Left	F	0.84	1.13	1.00
hind leg	T	0.92	1.13	0.90
Left	1			4.50
fore tarsus	2+3+4			0.80

No. 104		IV-V	V-VI	VI-VII
Left	F	0.91	1.00	1.16
fore leg	T	0.83	1.00	1.00
Right	F	0.91	0.80	1.16
fore leg	T	0.83	1.00	1.00
Left	F		11.20	8.00
mid-leg	T		6.00	7.33
Right	F	0.91	0.80	1.50
mid-leg	T	0.66	0.90	1.33
Left	F	1.00	1.00	1.33
hind leg	T	0.91	1.00	
Right	F	1.00	1.00	1.00
hind leg	T	0.91	1.00	
Left	1			2.33
mid-tarsus	2+3+4			4.50

Table 14. Growth-ratios (a) of the regenerate appendages of *Phraortes kumamotoensis* at different instars of growth.

No.	1			2			10				23	53
	RFT	RFF	LFT	LFF	LMT	LMF	LHT	RHT	LHF	RHF	RFT	LHF
I - II												
II - III	3.61	2.46									0.72	
III - IV							4.36	4.36	5.00	4.90	2.20	
IV - V												2.72
V - VI			2.88	0.88	2.00	2.00	4.16	1.08	2.08	0.75	2.42	
VI - VII			1.00	1.90	1.20	1.30	2.30	1.50	1.50	1.20		
No.	30			32			31		40		41	
	RMT	RMF	LHT	LHF	RMT	RMF	RFT	RFF	RFT	RFF	RMT	RMF
II - III	5.50	5.50	5.50	5.50					2.50	3.00	1.87	1.87
III - IV					7.57	8.14	2.52	2.94				
IV - V							4.53	4.15				
V - VI	1.09	1.27	1.54	1.18					2.18	1.63		
No.	44			45			48		52		54	
	LHT	RHT	LHF	RHF	LMT	LMF	RHT	RHF	LHT	LHF	LMT	LMF
II - III	0.44	0.44	0.44	0.44	5.36	5.00	5.00	5.36	2.60	2.60	5.41	5.41
III - IV												
IV - V												
V - VI	2.45	1.63	1.63	2.27	2.62	2.75	3.12	3.00	3.00	2.10		

No.	47				54 b				55 b		58 b		
	LMT	LMF	LHT	RHT	LHF	RHF	LHT	LHF	LMT	RMT	LMF		
I - III	3.87	3.25											
III - IV	3.38	4.23											
IV - V			5.77	5.77	6.55	6.55	4.90	4.40	2.45	2.45	2.45		
V - VI			4.23	3.07	3.69	3.69	2.22	2.55	2.60	2.80	2.80		
VI - VII	1.44	1.33	2.55	3.55	2.22	2.22			1.62	1.50	1.50		

No.	59 b				57 b		67				72	
	RMF	LFT	LFF	RMT	RMF	RMF	LHT	RHT	LHF	RHF	LFT	
III - IV												
IV - V	2.45	3.46	3.69	3.61	3.53	2.07	5.40	5.60	6.66	6.66		
V - VI	2.70	6.00	5.44	5.33	5.00	2.27	4.90		5.09		1.08	
VI - VII	2.00											

No.	86				88		90				91	
	RHT	LFT	LFF	LHT	RHT	LHF	RHT	RHT	RHF	LHT	LHT	LHF
I - III												
III - IV	1.00											
IV - V		1.53										
V - VI	0.92	3.10	6.33	9.75	9.75	10.00	10.00	15.41	18.57	13.00	17.28	

No.	92		93		94	96			97	
	LHT	LHF	LMT	LMF	LFT	LMT	RMT	LMF	RHT	RHF
I - III										
III - IV										
IV - V										
V - VI	2.10	6.00	8.11	8.11	1.20	6.00	6.00	5.70	6.90	3.90.
VI - VII										

No.	98		100		102		103	
	LHT	LHF	LHT	LHF	RFT	RFF	RMT	RMF
I - III								
III - IV								
IV - V								
V - VI	10.80	11.70	5.70	5.70	10.50	10.00	8.88	7.22
VI - VII	7.57	7.71						

[illegible]

No.	220			221			222			223	
	MT	MF		HT	HT	HF	HT	HT	HF	HT	HF
IV - V	8.30	7.60		8.54	8.27	8.54	10.87	7.50	10.87	9.87	8.45
V - VI	6.71 (6.14)	4.42		4.70	-0.30	5.40	4.07 (4.15)	4.92 (5.84)	4.38	3.92	5.08 (3.83)
VI - VII				4.71	-1.85	3.85			1.71	2.50 (1.40)	1.90

No.	224		225		226			227			229	
	HT	HF	HT	HF	HT	HT	HF	MT	MF		HT	HF
IV - V	5.38	5.23	9.27	8.63	7.50	7.60	7.00	8.50				
V - VI	8.00	8.11	5.60 (4.60)	5.90	3.33	6.20	5.10	5.10			9.10	9.40
VI - VII			2.09 (1.54)	1.90	3.44	2.77	2.33	2.55	10.16	8.00		

No.	230			232				234	
	HT	HT	HF	FT	FF	FF	HT	HT	HF
IV - V	17.11		17.11						
V - VI	16.00	42.00	13.66	42.66			3.00	9.76	9.46
VI - VII					0.88	0.88	0.00	4.33	5.22

No.	235		237		238	
	FT	FF	HT	HF	HF	
V - VI	3.00	4.50			4.00	
VI - VII			7.20 (3.10)	5.90		

No.	239				240				241			
	MT	MT	MF	MF	FT	FT	FF	FF	FT	FF	MT	MF
II - III	6.57			6.57	7.50	8.08			6.14	6.14		
III - IV	3.29 (2.82)	3.00	3.29	3.29	4.07 (3.14)	3.92	8.71	9.21	4.60 (6.30)	5.20	1.60	1.60
IV - V	4.28 (5.00)	9.14 (6.42)	8.42	4.14	3.66 (3.77)	3.66	7.11 (5.66)	4.77	4.12 (3.00)	3.37	6.75 (5.00)	6.75
V - VI	2.10 (1.70)	3.00 (2.40)	3.00	2.00	1.60 (-0.60)	1.30	1.30 (1.80)	2.40	2.00 (1.14)	1.50	2.21 (1.21)	2.35
VI - VII					1.55 (1.88)	1.55						

No.	243				244				245			
	MT	MF	HT	HF	MT	MT	MF	MF	FT	FF	HT	HF
II - III			6.66	6.66	8.33		8.33		4.06	5.20		
III - IV	10.25	10.41	4.75 (4.75)	5.33	1.76 (1.84)	9.46	2.84	8.07	6.60 (7.40)	5.70	10.00	10.00
IV - V	5.45	5.27	3.27 (1.90)	2.81					2.30 (2.00)	2.00	3.46	3.46
V - VI	3.00 (1.88)	3.11	2.77 (1.22)	2.44					1.63 (0.81)	1.54	1.81	2.00
VI - VII					2.00 (0.75)	1.50 (0.75)	1.12	1.75	1.77 (1.66)	1.44	1.44	1.55

No.	246				247				248			
	HT	HT	HF	HF	MT	MF	HT	HF	MT	MT	MF	MF
II - III		5.20		4.53	6.00	6.00						
III - IV	9.70	5.20 (7.30)	9.70	6.20	4.76 (3.69)	4.76	0.53	0.53				
IV - V	4.61 (4.15)	2.38 (1.61)	4.23	1.53	1.69 (0.61)	1.38	3.00	4.15	3.78 (3.81)	1.68 (1.06)	3.62	1.06
V - VI	2.70 (0.90)	2.30 (0.60)	2.80	3.00	1.77 (0.55)	1.88	7.66	7.00	1.25 (0.50)	1.91 (1.08)	1.75	-0.25
VI - VII					1.33 (1.88)	1.44			1.62 (0.00)		1.25	

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No.

	FT	FF	MT	MF	HT	HT	HF	HF
III - IV			5.84	5.84	13.69		14.00	
IV - V			5.50 (4.10)	5.40	1.20 (1.40)	4.00	1.20	5.00
V - VI	6.40	6.00	2.40 (1.30)	2.50	1.60 (0.00)	2.50	1.40	5.60

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No.

	MT	MT	MF	MF	HT	HT	HF	FT	FF	HT	HT	HF	HF
II - III	4.35										5.00		5.00
III - IV	4.07 (4.07)	7.69	3.61	7.69				8.27	8.27		5.27 (4.27)		4.63
IV - V	2.14 (1.00)	3.14 (2.64)	1.64	3.35	6.50		6.50	6.00 (5.00)	6.00	10.20		9.90	3.00
V - VI	1.62 (1.65)	2.62 (1.62)	2.00	2.75	4.87		6.37	3.00 (2.30)	2.70	6.40 (3.40)	2.00 (1.70)	6.20	2.10
VI - VII	1.18 (0.45)	1.27 (0.45)	1.00	1.09	2.54 (-1.00)		2.90						

254

No.

	MT	MF	HT	HT	HF	HF	FT	FF	MT	MF	HT	HT	HF
II - III			8.60		8.80								
III - IV			3.50	4.50	3.00	4.78	10.81	11.45				4.50	4.50
IV - V	9.81	9.72	2.36	5.27 (4.36)	2.45	4.36	4.08	4.75	7.58	9.00		4.45 (5.45)	4.90
V - VI	4.50 (3.00)	4.90	1.40	1.90 (1.80)	1.50	2.30	5.00	4.14	2.42	6.85		2.50 (1.91)	2.16
VI - VII	2.20 (1.54)	1.72	0.81	1.27 (0.27)	1.09	1.36						3.00 (0.28)	2.85

No.	255					256				
	MT	MF	HT	HT	HF	FT	FF	HT	HT	HF
II - III				7.80	6.80	9.75	9.75			
III - IV			8.27	4.72 (6.36)	8.27	3.13 (4.06)	3.46		6.06	6.06
IV - V	7.58	7.83	4.66 (4.00)	2.41 (1.08)	4.50	2.33 (2.50)	2.50	1.79	4.41 (2.25)	9.00 3.91
V - VI	5.77 (6.44)	5.44	2.00 (1.44)	1.22 (0.88)	2.22	1.70 (0.80)	1.40	5.30 (2.50)	1.90 (1.90)	4.30 2.50
VI - VII	2.10 (1.20)	2.30	1.30 (1.10)	1.40 (0.80)	1.30	1.55 (0.66)	1.11	2.20 (2.11)	1.77 (2.11)	2.33 1.33

No.	257					258				
	FT	FF	MT	MT	MF	MT	MT	MF	MF	HT
II - III				5.62	5.62					7.16
III - IV			5.76	1.23	6.23	7.05		7.18		2.93 (3.18)
IV - V	9.90	10.50	-2.40	6.90	-2.00	6.00 (4.80)	10.80	5.70	11.00	3.40 (1.90)
V - VI	4.54	4.63	9.54	-7.18	8.54	3.00 (2.20)	6.00 (2.50)	2.60	5.50	2.40 (1.70)
VI - VII	2.08 (0.91)	1.91	1.08	0.83	1.41					

No.	259					260				
	HT	HT	HF	HF	FF	FT	FF	HT	HT	HF
II - III		6.25		6.00						
III - IV		3.92 (5.00)		4.14	10.90	8.27		5.45 (4.36)		5.18
IV - V	9.83	2.50 (0.83)	9.25	2.16	4.63	3.18	9.00	1.90 (0.72)	8.63	1.90
V - VI	7.57 (4.50)	3.14 (2.42)	7.85	3.14	2.09	2.00	5.36 (3.90)	1.36 (0.45)	5.18	1.09
VI - VII					2.33	3.33	3.16 (1.16)	1.66 (2.33)	3.83	1.83

No.	261						262					
	MT	MT	MF	MF	HT	HF	FT	FF	MT	MF	HT	HF
III - IV	4.41 (3.50)	7.58	4.16	7.53			3.75 (3.00)	3.18			6.25	6.25
IV - V	2.54 (1.72)	4.72 (3.36)	2.27	4.81	9.81	9.81	2.50 (2.10)	2.90	10.80	11.10	5.60 (4.10)	5.10
V - VI	1.90 (1.27)	2.63 (2.45)	2.27	2.18	5.09 (4.18)	4.81	2.40 (1.60)	2.00	5.30	5.00	2.50 (2.20)	2.70

No.	263						264					
	FT	FF	MT	MF	HT	HF	FT	FF	MT	MF	HT	HF
III - IV			4.00	3.64	7.14	6.92			4.75 (3.33)	4.25	7.91	7.91
IV - V	8.33	9.83	2.75 (1.41)	1.91	4.41 (4.41)	4.50	7.20	7.20	2.00 (1.13)	1.86	3.73 (3.66)	3.53
V - VI	7.44 (6.11)	5.50	1.77 (1.44)	2.55	3.44 (1.88)	3.33	6.33 (3.33)	6.66	2.33	2.33	4.11 (1.66)	4.00

No.	265						266						267					
	FT	FF	MT	MF	HT	HF	FT	FF	HT	HT	HF	MT	MF	HT	HT	MF	HT	HF
III - IV			7.15	7.00					7.69	7.69			6.80	7.80				
IV - V		11.00	4.50 (4.50)	4.70	7.14	4.07 (3.28)			7.14	2.64		4.42 (2.21)	3.85	2.92				3.21
V - VI		5.00	1.91 (1.33)	1.91	7.44	3.55 (2.88)			6.66	3.77		2.55 (2.77)	2.66	7.55				8.44
VI - VII	5.50 (4.87)	3.75	1.75 (1.00)	2.25								1.66 (1.00)	1.88	3.33 (2.88)				3.77

No.	268				269				270			
	MT	MF	HT	HF	MT	MF	HT	HF	MT	MF	HT	HF
III - IV	7.75	5.16							7.30	8.30		
IV - V					4.25 (3.25)	4.83			5.07	4.07		
V - VI			9.10	9.10	2.80 (2.10)	2.50	-1.40	3.00	-2.87	1.61		
No.	272				273				274			
	HT	HT	HF	HF	FT	FT	FF	FF	MT	MF	HT	HF
III - IV	8.27		8.27		7.30				9.09	9.09		
IV - V	4.50		4.33		4.81 (3.90)			4.45	4.27 (3.81)	4.27	7.36	7.00
V - VI	2.30	9.70	2.40	9.10	3.10 (2.10)	11.10		3.00	2.09 (1.72)	2.27	6.36	6.27
VI - VII	1.33 (1.55)	-0.22 (-1.00)	1.44	6.00					1.75 (0.50)	1.50	4.50 (3.25)	4.25
No.	275				277							
	FT	FF	FT	FF	MT	MF						
III - IV	6.46	8.00	5.05	5.05								
IV - V	5.00 (4.35)	3.85	5.55	6.11	10.11	6.77						
V - VI	4.11 (3.33)	3.55	3.00	2.60	3.90 (3.10)	4.60						
VI - VII					2.88 (3.33)	2.11						

No.	298					299				
	FT	FF	MT	MF		FT	FF	HT	HF	HF
I - II							-1.04			
II - III							2.50			
III - IV			4.06	4.66		-0.83	2.91			
IV - V			5.40 (4.50)	4.50		4.45	1.72	0.81	9.81	9.81
V - VI	-0.91	5.41	2.41 (1.66)	1.91		3.80	2.10	3.10	4.80	4.80
VI - VII						2.27	1.18	0.63	2.00	2.00

No.	300					301				
	CT	CO	MT	MO		MT	MO			
I - II				0.00			-1.66			
II - III				-1.61			2.12			
III - IV			4.69	1.61			1.87			
IV - V	5.27	5.00	4.27 (3.45)	4.00		2.45 (4.90)	2.63			
V - VI			1.91 (0.40)	1.60		1.90	1.80			
VI - VII			1.50 (1.90)	1.00						

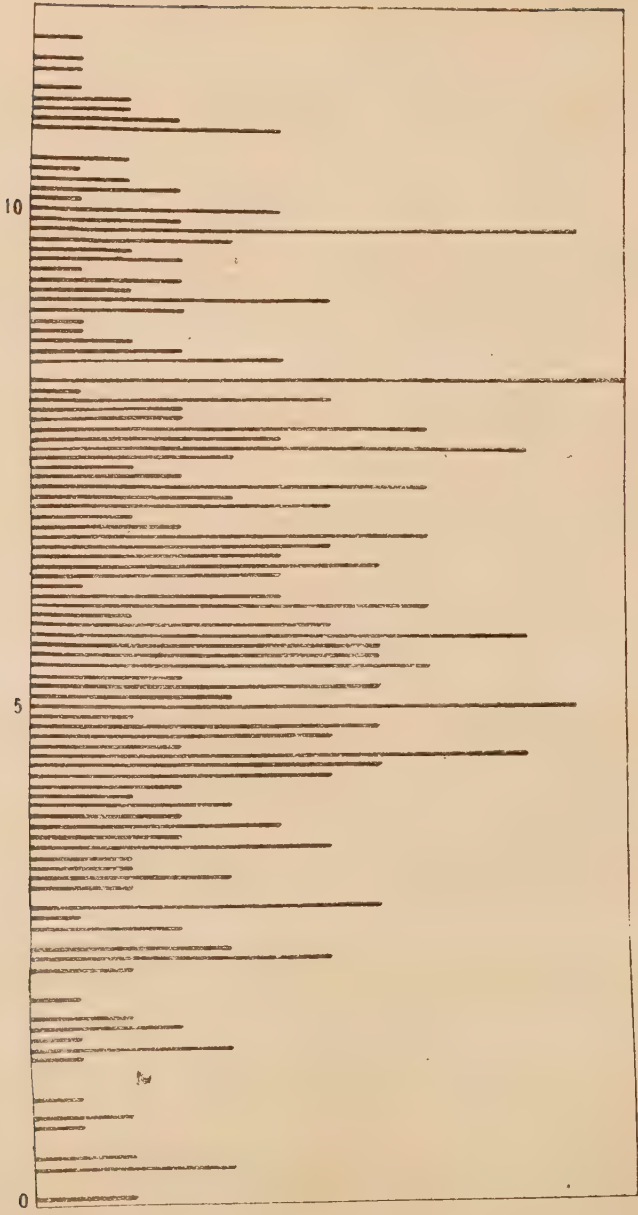


Fig. 8. Frequency distribution of the growth-ratios of the regenerate appendages (femora and tibiae) of *Phraortes kumamotoensis* in the second regeneration phase.

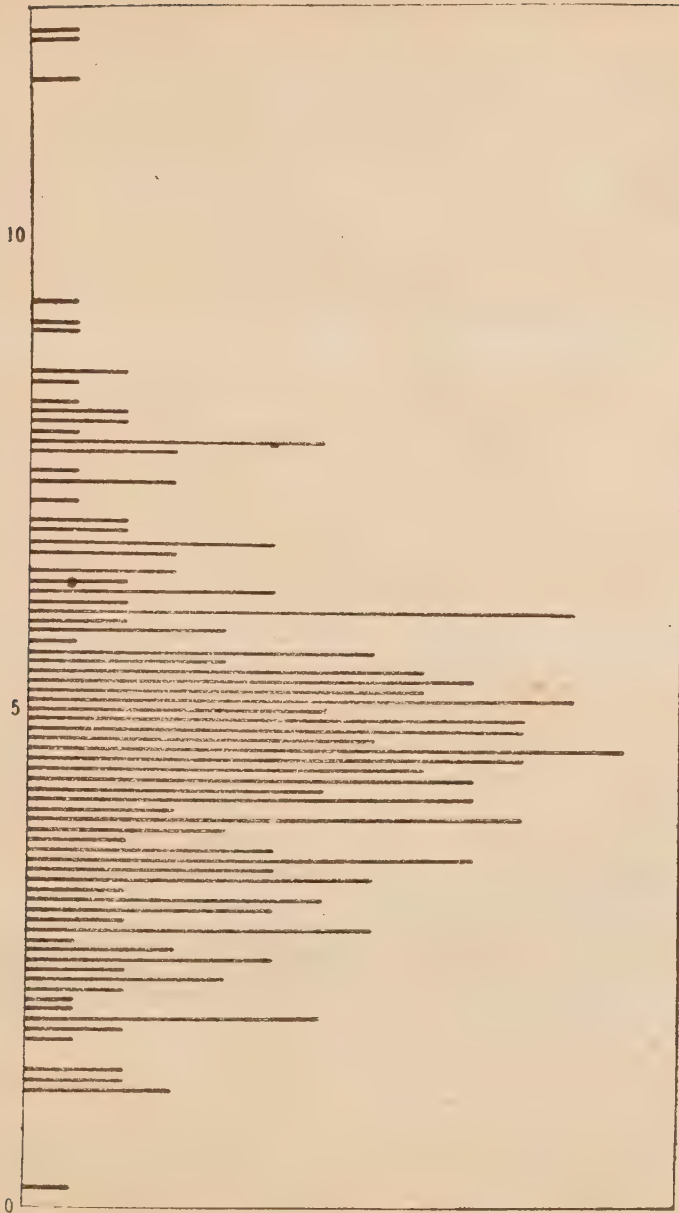


Fig. 9. Frequency distribution of the growth-ratios of the regenerate appendages of *Phraortes kumamotoensis* in the third regeneration phase.



Fig. 10. Frequency distribution of the growth-ratios of the regenerate appendages of *Phraortes kumamotoensis* in the fourth regeneration phase.

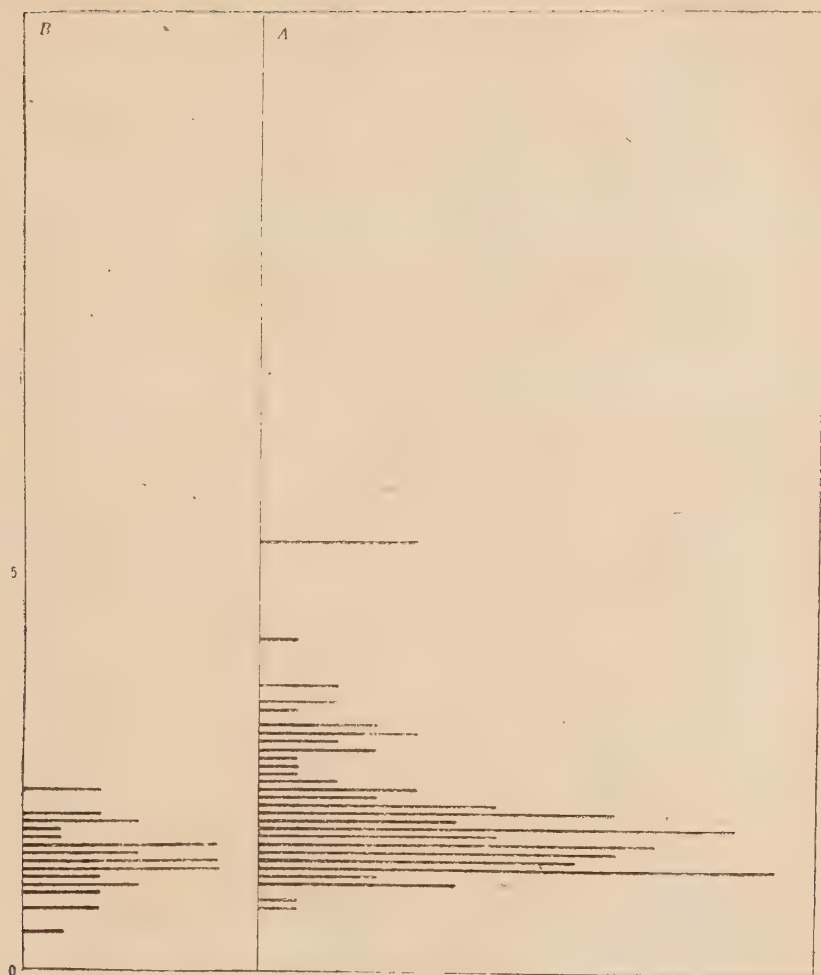


Fig. 11. Frequency distribution of the growth-ratios of the regenerate appendages of *Phraortes kumamotoensis*. A: The fifth regeneration phase. B: The last regeneration phase.

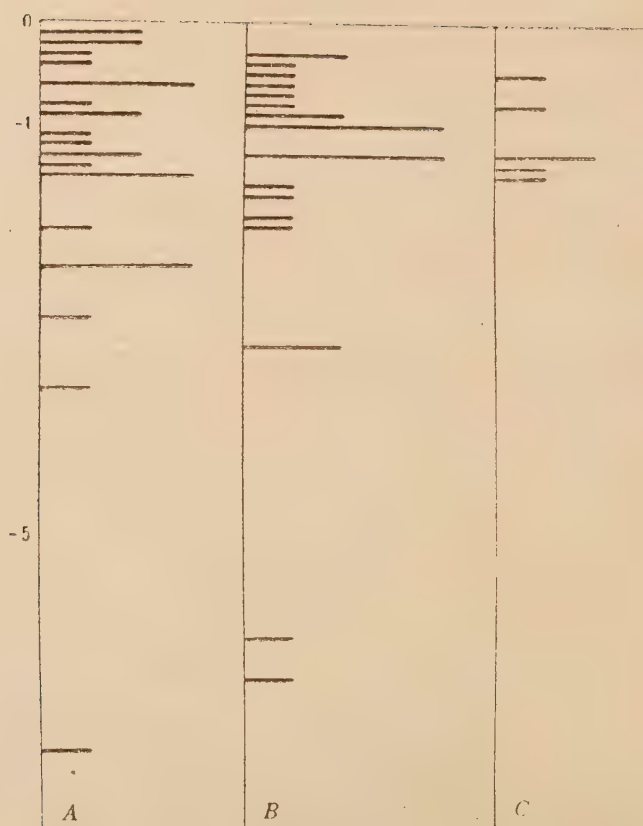


Fig. 12. Frequency distribution of the growth-ratios of the regenerate appendages (femora and tibiae) (the case of enantiometry) of *Phraortes kumamotoensis*. A: The second regeneration phase. B: The third regeneration phase. C: The fourth regeneration phase.

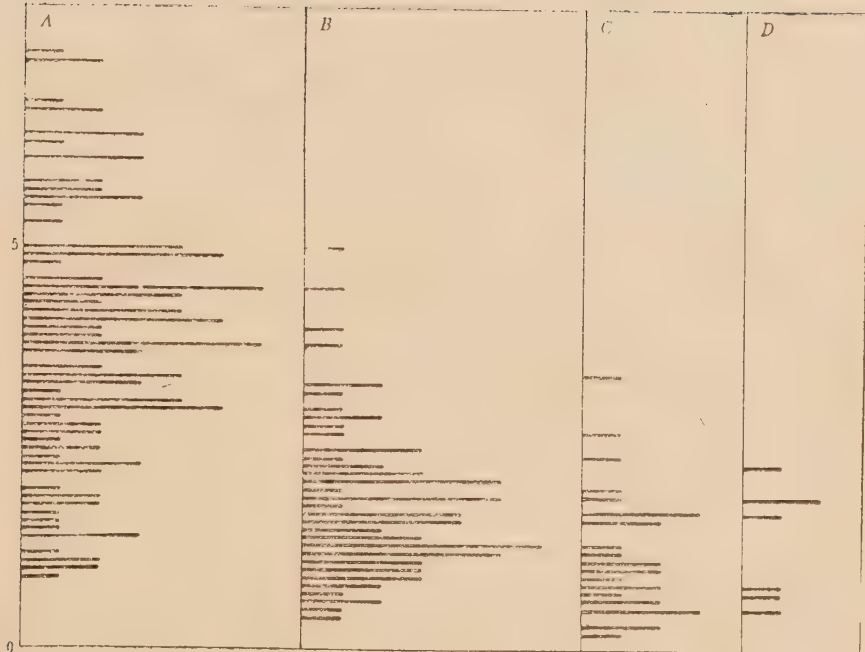


Fig. 13. Frequency distribution of the growth-ratios of the regenerate metatarsus of *Phraortes kumamotoensis*. A: The second regeneration phase. B: The third regeneration phase. C: The fourth regeneration phase. D: The fifth regeneration phase.

5. Regeneration Curves

Many methods have been employed in picturing the growth of insects or in determining the rate of growth. Most of such informations have been drawn in use of ordinary graph paper where weights, or other measurable units are plotted against the instar, the intervals of instars being taken in a same scale. Such a graph serves admirably to express the phenomenon of regeneration and may show the universal fact that the early growth of the regenerate is most rapid and the initially accelerated growth diminishes in velocity with age. However, such a method fails in the main purpose of showing the growth rate. Taking the length of the mesonotum as a standard growing organ and the other regenerating organs as the differential growing parts, I fitted the data into the expression of HUXLEY (*loc. cit.*). Such a graph may indicate the true rate of regeneration through the comparative modifications in the slope of the line. As stated by WOODRUFF (1938) the features of a curve which attract the greatest attention are concerned with the direction or the slope of the curve. In this way the regeneration curves of my study were obtained as shown in figures, and the following facts with regard to the changes of the pace can be detected immediately without any slight danger of misinterpretation. So far as my experiments are concerned, PRZIBRAM's statement (1917, 1919), that the regeneration is an accelerated growth (this was proved to be true by the so-far existing experiments), seems to be insufficient to explain the whole phenomenon of regeneration and needs a revision to a certain extent. My careful investigation of a number of regeneration curves of any part of appendages may indicate the fact, that the regeneration curves may be classified into several groups. In spite of some irregularities, the following four trends of regeneration curves are to be noted during the course of normal regeneration.*

A. *Decreasing type* (PRZIBRAM, 1917). In this type of regeneration curve the decreasing of the rate with age is perfectly evident. To this type the following experiments belong: Nos. 36, 30, 34, 54b, 66, 69, 74, 49, 273, 11, 101, 244, 241, 265, 277, 240, 245, 270,

* Regeneration caused by autotomy.

275, 254, 263, 251, 256, 3, 47, 52, 77, 204, 220, 36, 58b, 30, 45, 65b, 66, 249, 267, 269, 274, 200, 252, 255, 250, 258, 261, 239, 298, 262, 243, 247, 219, 248, 53, 33, 68, 55b, 80, 218, 223, 225, 226, 234, 222, 65b, 69, 82, 10, 44, 208, 221, 263, 260, 299, 266, 272, 219, 264.

B. *Intermediate type* (new type). In this type of regeneration curve the decreasing of the rate with age is recognizable in the earlier period, then followed by the increasing of the rate in the later period, or the increasing of the rate with age is seen in the earlier period, then the decreasing of the rate follows in the later period. To this type belong the following experiments: Nos. 35, 49, 40, 58, 211, 260, 4, 35, 241, 264, 205, 6, 25, 48, 56, 63, 10, 37, 201, 259, 249, 267, 200.

C. *Uniform type* (new type). In this type of regeneration curve the rate of regeneration may be expressed by a straight line throughout the development. To this type belong the following experiments: Nos. 300, 264, 15, 104, 254, 218, 98, 67, 259, 249, 219, 57b,

D. *Increasing type* (new type). In this type of regeneration curve the increasing rate with age is noted. To this type belong the following experiments: Nos. 59b, 31, 239, 60, 247.

The following table gives the distribution of these four types of regeneration curves in my experiments.

Table 15. Frequency of four types of regeneration curves in experiments (Figure in %).

Types Legs	Decreasing	Intermediate	Uniform	Increasing
Fore femur	72.22	16.66	8.33	3.79
Fore tibia	71.42	17.14	8.57	2.87
Mid-femur	80.85	8.51	6.38	4.26
Mid-tibia	80.85	10.63	4.26	4.26
Hind femur	66.19	19.71	9.85	4.25
Hind tibia	66.19	25.35	7.04	1.42
Average	72.87	16.42	7.32	3.39

As seen in the table given above, the frequency distribution of the four regeneration curves shows that the decreasing type is

the commonest among the four reaching as high as 72.87 per cent and the intermediate type occurs as often as 16.42 per cent. Both the uniform and increasing types may be rarely observed, amounting only 7.32 and 3.39 per cent respectively. Further it must be stressed that the slope of the regeneration curve of the basitarsus is always steeper than that of the remaining parts of the tarsus.

In the review of literature it is found that no thorough investigation has hitherto been carried out upon possible correlation among the components (femur, tibia, tarsus) in a regenerate leg during the course of the regeneration in insects. Nevertheless it was supposed by me that there should exist some positive or negative correlation at least between the femur and tibia in a regenerate leg. I traced such relation in both the regenerating femur and tibia by analyzing the regeneration curves in question. The following four tables represent the correlation among the four types of regeneration curves of femur and tibia.

Table 16. Correlation among four types of regeneration curves of femur and tibia (Fore leg, %).

		Femur			
Tibia	Types	Decreasing	Intermediate	Uniform	Increasing
	Decreasing	73.52		2.94	
	Intermediate	2.94	14.70		
	Uniform			2.94	
	Increasing				2.94

Table 17. Correlation among four types of regeneration curves of femur and tibia (Mid-leg, %).

		Femur			
Tibia	Types	Decreasing	Intermediate	Uniform	Increasing
	Decreasing	76.59		2.12	
	Intermediate	2.12	8.51		
	Uniform	2.12		4.25	
	Increasing				4.25

Table 18. Correlation among four types of regeneration curves of femur and tibia (Hind leg, %).

	Types	Femur			
		Decreasing	Intermediate	Uniform	Increasing
Tibia	Decreasing	63.38	1.40	1.40	
	Intermediate	2.81	21.12	1.40	
	Uniform	2.81		4.25	
	Increasing				1.40

Table 19. Correlation among four types of regeneration curves of femur and tibia (Average).

	Types	Femur			
		Decreasing	Intermediate	Uniform	Increasing
Tibia	Decreasing	69.73	0.01	1.97	
	Intermediate	2.63	15.78	0.01	
	Uniform	3.94		3.94	
	Increasing				2.63

Theoretically we may be able to produce sixteen cases of combination of four types of the regeneration curves between femur and tibia, *i.e.* :

Decreasing-decreasing type (69.73 % in my experiments)

Decreasing-intermediate type (2.63 %)

Decreasing-uniform type (3.94)

Decreasing-increasing type (no case in my experiments)

Intermediate-decreasing type (0.01 %)

Intermediate-intermediate type (15.78 %)

Intermediate-uniform type (no case)

Intermediate-increasing type (no case)

Uniform-decreasing type (1.97 %)

Uniform-intermediate type (0.01 %)

Uniform-uniform type (3.94 %)

Uniform-increasing type (no case)

Increasing-decreasing type (no case)

Increasing-intermediate type (no case)

Increasing-uniform type (no case)

Increasing-increasing type (2.63 %)

As demonstrated above it is well understood that there exists a distinct and high correlation between the femur and tibia in a regenerate leg throughout the period of post-embryonic growth. It must be noted that the combinations of the same type of regeneration curve are predominant in the regenerate process. Thus the decreasing-decreasing type encountered in my experiments was 69.73 per cent in frequency, the intermediate-intermediate type being 15.78 per cent, the uniform-uniform type being 3.94 per cent and the increasing-increasing type being 2.63 per cent.

Next considerations must be given to the regeneration curve of regenerates which are amputated at any point across the longitudinal axis except the trochantero-femoral groove. In general, the regeneration curve of a femur which has lost its apical part by operation takes J-shaped curve (J-type), the highly decreasing rate with age is evident in the earlier period or the curve runs down below along the X-axis, and then the curve takes the type same as the decreasing one of the normal regeneration. (Nos. 282, 283, 284, 285, 292, 293, 13, 12, 287, 291, 296, 301, 14, 55, 280, 17, 288, 294, 297, 71, 278, 281, 299, 300). The growth curve of a newly regenerated tibia or tarsus takes the following types:

Decreasing type (Nos. 282, 283, 284, 292, 13, 287, 296, 301, 300)

Intermediate type (Nos. 293, 288, 294)

Uniform type (Nos. 285, 293, 57, 301, 55, 297)

Increasing type (Nos. 284, 12, 278)

J-type (Nos. 294, 299)

This last type was very rare to be met with in the regenerating tibia. The regeneration curve of a tibia which has lost its apical part by amputation takes the following types:

Normal growth type (Nos. 81, 86, 87)

Intermediate type (Nos. 23, 24, 62, 73, 79)

Increasing type (Nos. 75, 76, 59)

The regeneration curve of a tarsus which has lost its entire distal parts except for the base of the metatarsus by operation takes the following types:

Decreasing type (No. 84)

Increasing type (No. 27)

The regeneration curve of an antenna which has lost its almost entire flagellum except for the extreme base by amputation takes the following types:

J-type (No. 11)

Decreasing type (Nos. 53, 8, 7)

Intermediate type (Nos. 18, 19, 50)

Uniform type (Nos. 39, 7)

Increasing type (Nos. 64, 46)

As are shown in my interpretation based upon many data, the regeneration curves of appendages in *Phraortes kumamotoensis* are classified into six types, *viz.*, the decreasing, intermediate, uniform, increasing, *J*, and though rarely, the normal growth types, of which the first one has hitherto been recorded by many authors.

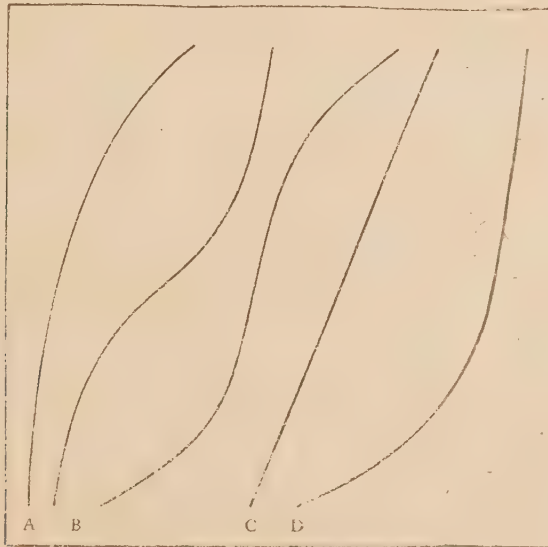


Fig. 14. Idealized regeneration curves of *Phraortes kumamotoensis*.

A: Decreasing type. B: Intermediate type. C: Uniform type.

D: Increasing type.

Further it may be mentioned that the intermediate type contains two different cases.

These results may strike some future investigators, who attempt to place the growth of the regenerate on a mathematical basis, and suggest that any attempt to express the rate of regeneration in insects by a single formula must be practically impossible and must not be recommended for an enterprise owing to the existence of several types of regeneration curves which are of a totally different nature.

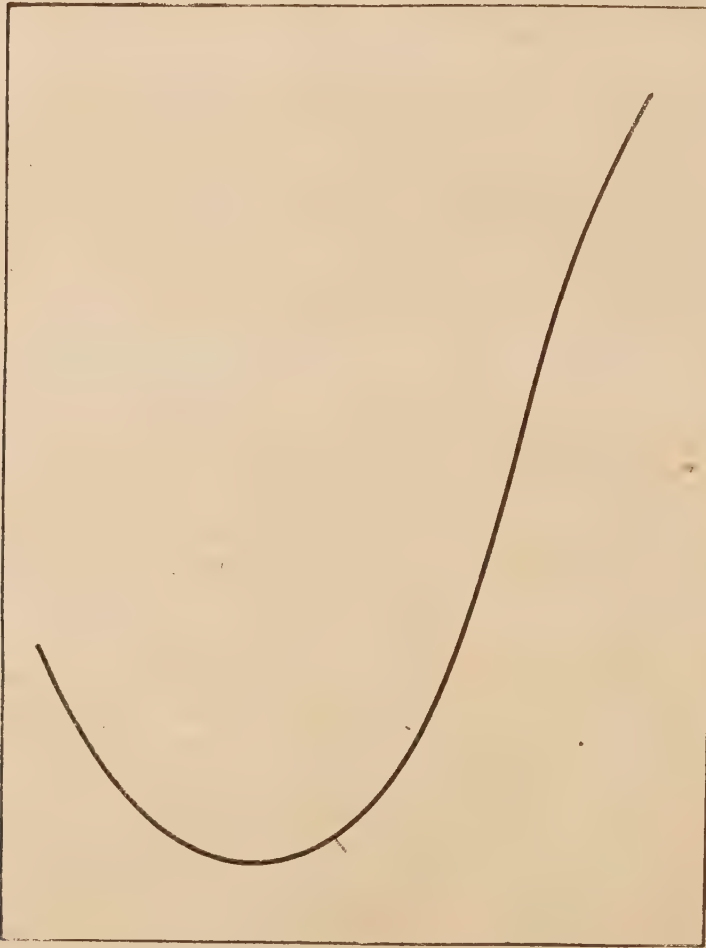


Fig. 15. An idealized regeneration curve of *Phraortes kumamotoensis*.
J-type.

6. Promoting and Inhibiting Factors of the Growth

It is a known fact that the removal or partial removal of an organ results in more or less accelerated growth at the site of wound. In the case of appendages, the newly started growth is most rapid if the removal is effected at the level where autotomy occurs, and enantiotomy is seen if the removal is effected at the level where autotomy does not occur, provided that conditions are equalized by keeping the material at the same nutritive level. And it must not be forgotten that the result may distinctly be classified into several definite types as mentioned in the previous chapter, though grade of stimulus on wound is different in each experiment (it is almost impossible to give exactly the same grade of stimulus or wound to all the material which may be reared in the same condition). It is natural to suppose that the influence which moulds the outgrowth of a new appendage seems to reside in the epidermis itself. Further it may not be worthy of mention that the relative size of organs may be generally pictured as a competition between the amount of material in the organ and the amount of the material in the body, or it appears to be determined as an equilibrium between them. Thus the influence which moulds the outgrowth of a new appendage or the relative size of appendages is due to two factors, one being its inherent growth-capacity and the other being a regulatory partition-coefficient which allots material between the organ and the rest-of-body, and this is equally true both for normal and regenerate or even for transplanted appendages. In my regeneration experiments, such monomodal regeneration curves as of decreasing-type, increasing-type and J-type suggest clearly that there is a mutual influence of two components or factors upon each other. I want to call these factors as growth-promoting and growth-inhibiting ones. These two factors seem to reside in the epidermis of the appendages themselves (on any part where regeneration may take place) and have no direct relationship with the amount of material in the body. Further these two factors seem to be different from the so-called amount of material in the organ in the case of normal developmental growth. The growth of the regenerates as a whole is of an intermediate rate. Namely the rate of the rapid component, or the growth-promoting factor, is slowed down, and that

of the slow component, or the growth-inhibiting one, is speeded up. Generally the distribution of the two factors along the longitudinal axis within each segment of an appendage seems to be quite definite, *i.e.* the growth-promoting factor being much the densest at the extreme apex, while the growth-inhibiting one being homogeneously dense. In rare cases the distribution of these two factors in the trochanter seems to be quite different, sometimes two being homogeneous and sometimes the growth-promoting being basal instead of apical in distribution. My experimental data show that the action of the growth-promoting factor seems to stimulate the growth-inhibiting one, and *vice versa*. In normally developing appendages an equilibrium between the two factors appears to be retained in each instar in all the segments of the appendage. Complete removal of a femur implies a complete exposure of the growth-promoting factor in the trochantero-femoral part, and such an operation results a highly positive action of the growth-promoting factor and a highly accelerated growth at the site of the wound in general. On the other hand the activity of the growth-promoting factor makes an impulse to the same of the growth-inhibiting factor, and there is seen a progressive loss in the growth-promoting power as the insect grows older. The partial removal of an appendage implies exposure of a part where the relative density of the growth-promoting factor is low and the same of the growth-inhibiting factor is very high. As the result of the partial removal of an appendage, enantiometry follows after the operation. But gradually the growth-promoting factor is concentrated at the wounded part and then a highly accelerated growth takes place in later instars. Practically an exposure of the actual apex of femur, tibia or any other apical segments, where the growth-promoting factor is distributed in high density, is impossible so far as the present method of operation goes. If such an operation could be done actually, then we should be able to expect a highly accelerated growth of a newly regenerated tibia or any other following segment as in the case of autotomy. With the aid of such an idea of the growth-promoting and growth-inhibiting factors we may be able to explain a phenomenon of overgrowth of a regenerate quite easily.

From my experiments the two factors seem to reside and to be distributed also in the scape and pedicel of antennae as in the

case of other appendages. In the antennal flagellum both the factors, capable of producing only the flagellum, seem to be distributed somewhat homogeneously. Therefore the regeneration curve of the antennal flagellum is almost similar to that in the normal case. As far as these growth factors are concerned, the basal two segments of the antennae are homologous to the seg-

Fig. 16. A diagram of a leg showing the distribution of the growth-promoting and growth-inhibiting factors along the longitudinal axis.

Cx: Coxa Tr: Trochanter

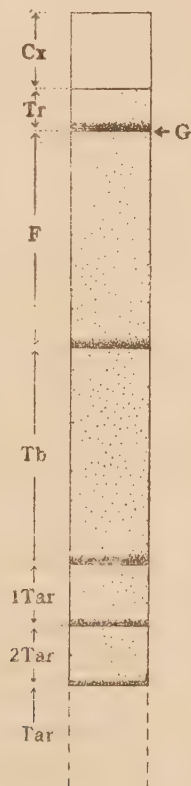
G: Trochantero-femoral groove

F: Femur Tb: Tibia

1Tar: 1st tarsal segment

2Tar: 2nd tarsal segment

3Tar: 3rd tarsal segment.



ments of the legs (trochantero-femoral groove, femur, tibia, *etc.*), but the antennal flagellum is somewhat different from those two segments both in nature and distribution of the factors.

7. Abnormal Regenerates

The most important feature between normal and regenerate legs is the number of tarsal segments. As is well known by the three laws of regeneration of BRINDLEY (1898), a regenerate tarsus of Blattidae, Mantidae and Phasmidae—Orthoptera pentamera—constantly presents a tetramerous tarsus instead of that with five segments. As early as 1899 BORDAGE (1899) showed the following insects as examples exhibiting this feature:

Phasmidae (BORDAGE's experiment)

Monandroptera inuncans, *Raphiderus scabrosus*,
Eurycantha horrida, *Phyllium siccifolium*

Mantidae (BORDAGE)

Mantis prasina, *Mantis pustulata*

Blattidae (BRISOUT, BATESON, and BRINDLEY)

Periplaneta americana, *Periplaneta australasiae*,
Periplaneta orientalis, *Blabera atropos*,
Nyctibora latipennis, *Nyctibora sericea*,
Epilampra cinerea, *Homalosilpha ustulata*,
Leucophaea surinamensis, *Monachoda grossa*,
Panesthia javanica, *Phyllodromia germanica*

This universally known fact was proved to be true in many other insects, for instance, *Carausius morosus* (DUSKOVA, 1926; FRIEDRICH, 1930; other authors), *Bacillus rosii* (GODELMANN, 1901), *Sphodromantis bioculata* (PRZIBRAM, 1906). With regard to a possible cause of this phenomenon, FURUKAWA (1935) published his opinion that the regulation to produce pentamerous segmentation instead of four-jointedness seems to be impossible in such cases owing to the fact that the larval body is more specialized than that of the embryo. His explanation for the cause of tetramerous tarsus seems to hold good for my experiments. If the regulation would actually be played in the regenerate appendages, then we could expect the occurrence of such as a one-, two-, three-, or five-segmented tarsus or even the entire lacking of the tibia or tarsus.

1. Cases in which the regenerate has one-segmented tarsus. No. 41 (Fig. 23, E, F)—Because of the constriction at the middle portion of the regenerate mid-femur, the growth of the tibia was

arrested and the tetramerous tarsus was reduced to a single-segmented one in the fifth instar. No. 62—The tetramerous tarsus was reduced to a very small single-segmented attachment in the sixth instar. In this individual it must be remembered that the operation was carried out near the middle portion of the mid-tibia. In both the cases tetramerous segmentation in the regenerate tarsus occurred at first, and the tarsus was reduced to a single-segmented one owing to some mechanical or physiological reasons. No. 74 E (Fig. 22, L, M, N)—The left-hand mid-leg of a larva was amputated at the middle portion in the second instar. The growth of the wounded leg was very slow. A regenerate tarsus first appeared in the fourth instar, and the tarsus was one-segmented even in the next instar.

2. Case in which the regenerate has two-segmented tarsus. No. 66—The left-hand mid-leg was lost by autotomy in the second instar. A two-segmented tarsus was regenerated in the fourth instar, but no more differentiation took place in the tarsus in question and the tarsus remained two-segmented even in the next instar.

3. Cases in which the regenerate has three-segmented tarsus. No. 12 (Fig. 20, I, J, K, L)—The right-hand fore femur of a newly hatched larva was amputated near the middle portion. In this individual reconstruction of the lost part was slow, and a three-segmented tarsus appeared after the last ecdysis. No. 300 G (Fig. 18, C)—The left-hand hind tibia was operated upon near the apex in the second instar, and a three-segmented tarsus was regenerated in the fourth instar. No further differentiation occurred in the tarsus in question. No. 300 F—This experiment gave the same result as in the case of No. 300 G.

4. Cases in which the regenerate has five-segmented tarsus. No. 57 (Fig. 19, A, B, C)—The growth of a wounded femur was highly affected by the reconstruction of the lost part. In the fifth instar a pentamerous tarsus was regenerated. The apical segment could not be considered as representing the pulvillus between the claws. Unfortunately however, this pentamerous tarsus was entirely etiolated after the next ecdysis. No. 10—Both the hind legs of a newly hatched larva were lost by autotomy. In the fifth instar a two-segmented tarsus appeared on the right side. Further differentiation took place in the tarsus and a pentamerous

tarsus was seen in the next instar.

5. Cases in which the regenerate has no tarsus. No. 74—The growth of the wounded leg was slow, and until the fourth instar no tarsus was regenerated at all. No. 92 (Fig. 19, H, G)—The growth of a regenerate tibia was slow, but no bud of a regenerate tarsus appeared at all. No. 224—The left-hand hind leg of a larva was lost by amputation in the third instar. In this individual the regenerate tarsus did not appear at all.

6. Cases in which the regenerate has no tibia. No. 55 (Fig. 22, I, J, K)—The growth of the wounded femur was highly arrested by the reconstruction of the lost parts. In the third instar the regenerate tibia appeared. In the fourth instar there appeared a two-segmented regenerate tarsus which was conspicuously constricted at the base. These feebly developed tibia and tarsus were etiolated in the next instar. No. 71 (Fig. 22, O, P, Q)—The growth of the wounded femur was not conspicuous. In the fourth instar a tetramerous tarsus appeared and was attached directly to the apex of the femur. In the next instar it was entirely diminished and the femur became oblong-conical in shape. No tibia was regenerated at all. No. 279—The growth of the wounded femur was highly affected by the reconstruction of the lost parts. In the third instar a bud of the tibia appeared, but it was diminished after the next instar.

On the evidence of the examples above cited it is not difficult to establish the following model of the differentiation-types in the regenerate legs, and such a model may throw some light on the determination of the role of the regulative power in the course of regeneration.

Table 20. Differentiation of the regenerate tarsus in the course of regeneration (Figures designate the number of tarsal segments).

Type	Before amputation	Amputation	After regeneration	Final number of segments	Reduction or multiplication
1	5	0	4	1	-3
2	5	0	2	2	0
3	5	0	3	3	0
4	5	0	5	5	0
5	5	0	2	5	-3

6	5	0	1	1	0
7	5	0	0	0	0
8	5	0	2	0	-2
9	5	0	4	0	-4

In 1915 H. O. SCHMIT-JENSEN reviewed some of the existing literature on homoeosis of the appendages in Arthropoda. To that author as well as to W. M. WHEELER (1896) and H. PRZIBRAM (1910) we owe most of our knowledge of this phenomenon occurring in the group of animals. According to them, homoeosis or heteromorphosis may be divided into three types as is shown in the following lines.

a: Substitutional homoeosis (WHEELER: substitutional homoeosis. PRZIBRAM: Ersatzhomoeosis). This type consists in supplanting of one appendage by another which normally belongs to a different body segment.

b: Adventitious homoeosis (WHEELER: redundant or adventitious homoeosis. PRZIBRAM: Zusatzhomoeosis). This type consists in the addition of a formation, which normally belongs to another segment, at a point which is already supplied with a normal appendage.

c: Transpositional homoeosis (PRZIBRAM: Versatzhomoeosis). This type consists in the transposition of appendages, which are absent in their normal position, to points on another segment.

In the first case it is a rule that less specialized appendages always supplant the more specialized if these are removed. In the case of adventitious and transpositional homoeosis, it is said that inherited variations and embryonic abnormalities both seem to play a part. As to the cause and the detailed account of the substitutional homoeosis FURUKAWA (1935) gave a complete review of the literature. In my experiments only the substitutional homoeosis was observed.

7. Substitutional homoeosis. No. 11 (Fig. 20, M, N, O)—and many other examples.

8. Addition of a new formation to the regenerate appendage. I do not dare to say that cases of No. 200 Aa and No. 216 C2 belong strictly to the so-called adventitious homoeosis. No. 200 Aa (Fig. 18, A)—The right-hand hind leg of a female larva was amputated from the trochantero-femoral suture in the first instar.

The regenerate small leg was once more amputated from the trochanterofemoral suture in the third instar. After the third ecdysis I observed a normal regenerate, but in the next, *i.e.* the fifth instar a curious additional regenerate appeared. The regenerate femur was almost normal in shape, but its apex was completely fused with the base of the tibia, leaving only a constriction between them. Further the tibia and the following portions became dark greenish in colour and very soft in texture, or not highly chitinized. The femur was provided with ordinary longitudinal ridges and about twice as long as the tibia. The apical portion of the tibia was recurved. Though the segmentation of the tarsal segments was not highly differentiated, four segments were able to be distinguished. Very interesting was the attachment of a new organ to the middle portion of the tibia. This new organ was very narrow but about as long as the tibia and almost perpendicular to the longitudinal axis of the tibia. This organ was composed of three segments and narrowed both basally and apically, the basal segment was as long as the following two segments taken together, and the apical one was very short. This additional organ may be regarded as representing an appendage.

No. 216 C2 (Fig. 18, B)—The right-hand mid-leg of a female larva was lost by autotomy in the first instar. In the third instar a very curious regenerate appeared. The regenerate femur was 1.8 mm in length with ordinary longitudinal ridges. The tibia was about 1.3 mm in length, very thick but very much constricted at the base where two folds were seen. There were also a wide fold and a small tubercle on the underside near the apex. The apex was very narrow and slightly narrower than the base. The tarsus was very small and three-segmented. The colour of the tibia was deep dark green. No longitudinal ridges were seen on the tibia as in the case of the preceding experiment. It is very important to record that a new appendage was attached to this tibia. The new organ was composed of four parts, namely: a supposed trochanter, supposed femur, supposed tibia and supposed tarsus. The longitudinal axis of the new appendage was perpendicular to that of the tibia. The supposed femur of it was 2.0 mm in length and not completely separated from the following tibia, but was provided with ordinary longitudinal ridges. The supposed tibia was cylindrical in shape, slightly narrower than the femur

and about 0.5 mm in length. The supposed tarsus was not divided into segments but with a small tubercle at the apex.

9. Case of proximo-distal symmetry. No. 82 (Fig. 19, M, N) — Apical 4.6 mm of the left-hand mid-femur of a female larva was amputated in the third instar. In the next instar the remaining part of the femur was very much reduced in size and the junction between the trochanter and the femur became very narrow in diameter. After the fourth ecdysis a very curious leg was regenerated. This curious and very interesting leg has many segments which exhibit a symmetrical arrangement along the proximo-distal direction of the regenerate. The third segment (femur) was provided with ordinary longitudinal ridges except the apical portion and was 2.1 mm in length. The fourth segment (tibia) was cylindrical, without any ridges and 2.0 mm in length. The fifth segment (basal segment of the tarsus) was also cylindrical and 0.5 mm in length. The sixth and seventh segments (the second and third tarsal segments) were 0.25 mm in length together. The eighth segment (the fourth tarsal segment) was 0.35 mm in length, slightly curved and furnished with an additional appendage at the middle portion of the underside. This secondary appendage was dark green in colour and two-segmented. The ninth and tenth segments (the third and second tarsal segments of the opposed half of the regenerate respectively) were of equal length and 0.30 mm taken together. The eleventh segment (basal segment of the tarsus of the opposed half) was wider than the fifth segment and 0.5 mm in length. The twelfth segment (tibia) was 1.5 mm in length and irregularly shaped with two notches beneath. At the end of this supposed tibia there was attached a blackish small segment. The longitudinal axis of this mirroring part was almost perpendicular to the same axis of the basal regenerate leg.

The experiments of FURUKAWA (1940), who made a number of transplantations in *Anisolabis maritima*, are very interesting in this connection. He obtained a series of cases of the proximo-distal symmetry of the antennae, but only by the transplantation of the scape and pedicel, but not of the flagellum. He concluded that each antennal segment can give rise to itself and the more distal segments, but cannot produce the more proximal segments, and further each segment can be transformed into the more distal segments. I suppose that a part of the regenerate tibia in Nos.

200 Aa and 216 C2 might have been injured in course of the experiment and this might become the cause or stimulus of the addition of a new organ. From these three interesting cases of regeneration

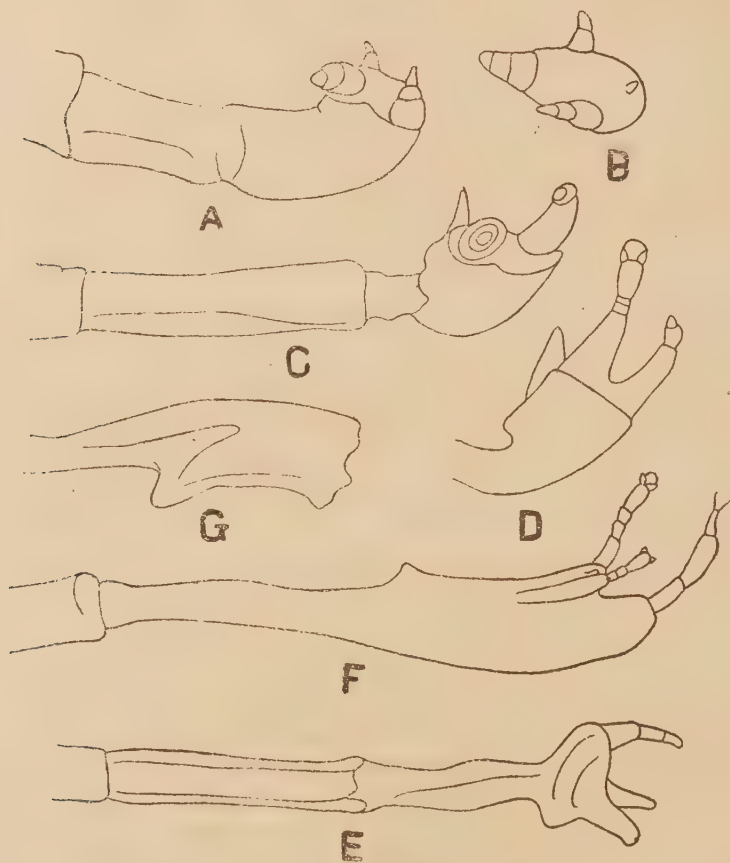


Fig. 17. Abnormal regenerates of *Phraortes kumamotoensis*.

A-C: No. R2i0Bb E-G: No. C220.

the following conclusions or assumptions may be derived. The proximo-distal symmetry of a regenerate may be produced not only by the transplantation (as in the case of the scape and pedicel in *Anisolabis maritima*), but also in the regeneration by means of the action of some stimuli. The regenerate tibia can produce not only the more proximal but also the more distal

segments. Thus the regenerate tibia of No. 216 C2 produced after an ecdysis a coxa, femur—tibia and further a tarsus.

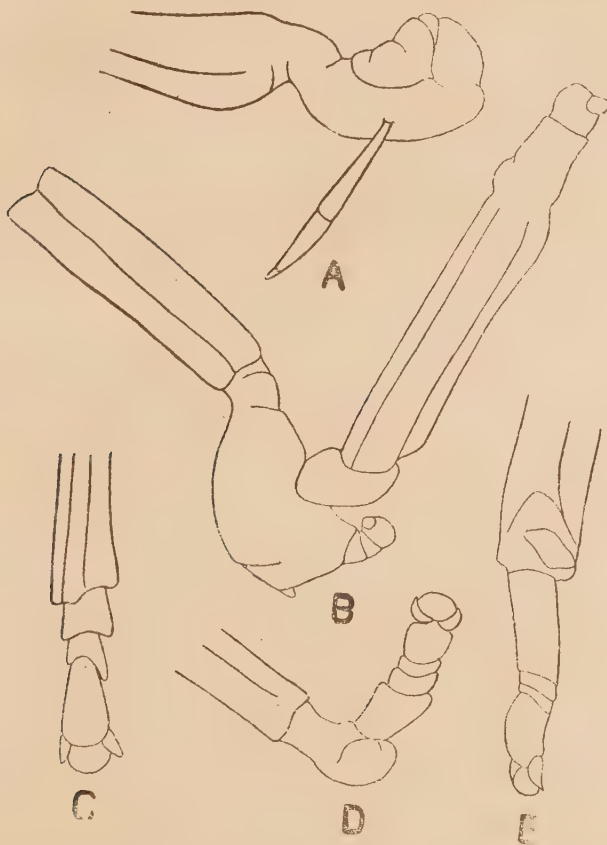


Fig. 18. Abnormal regenerates of *Phraortes kumamotoensis*.

A: No. 200Aa B: No. 216C2 C: No. 300G D-E: No. E220.

In the course of the post-embryonic growth the duplication and triplication of the regenerate may be produced by some injuries occurring upon the regenerate and are in fact fairly common phenomena among insects.

10. Duplication of the regenerate. No. 300 A (Fig. 21, A)—The right-hand mid-tibia of a female larva was amputated near the apex in the second instar. After the second ecdysis one-segmented tarsus was regenerated. After the third ecdysis three-

segmented tarsus appeared. The tarsus was very much narrowed towards the apex. The basitarsus was as long as the second

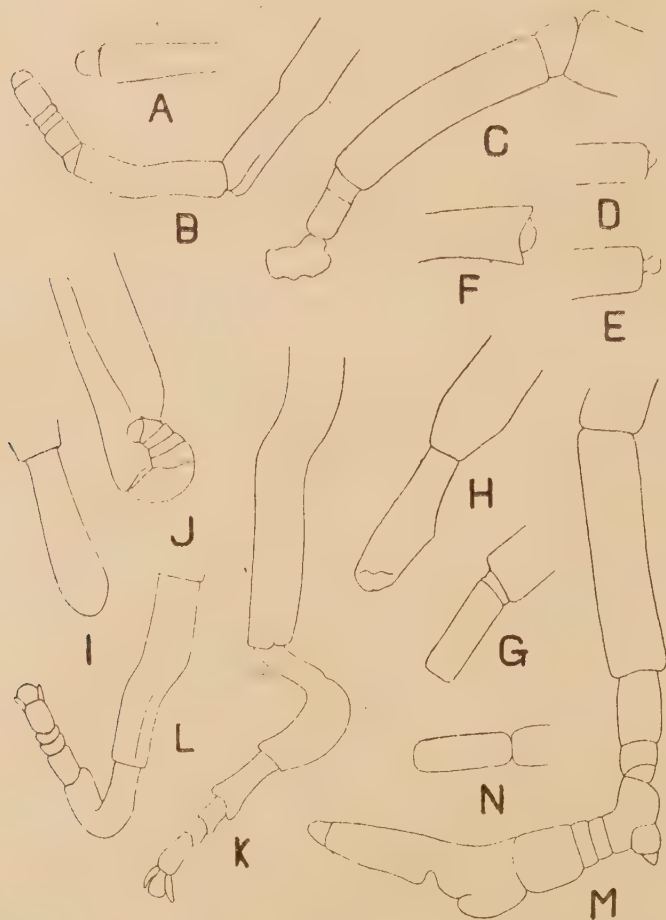


Fig. 19. Abnormal regenerates of *Phraortes kumamotoensis*.
 A-C: No. 57 D-F: No. 72 G-H: No. 92 I-J: No. 57B
 K-L: No. 17 M-N: No. 82.

segment, which was more than twice as long as the apical one. It is noteworthy that the basitarsus was biramous, with a lateral branch at the middle. No. 300 B (Fig. 21, H)—The left-hand hind femur of a male larva was amputated at the apex in the second instar. After the third ecdysis the regenerate tibia became

biramous, one branch was long, cylindrical and provided with the tarsus but the other was very short, narrow and curved along the

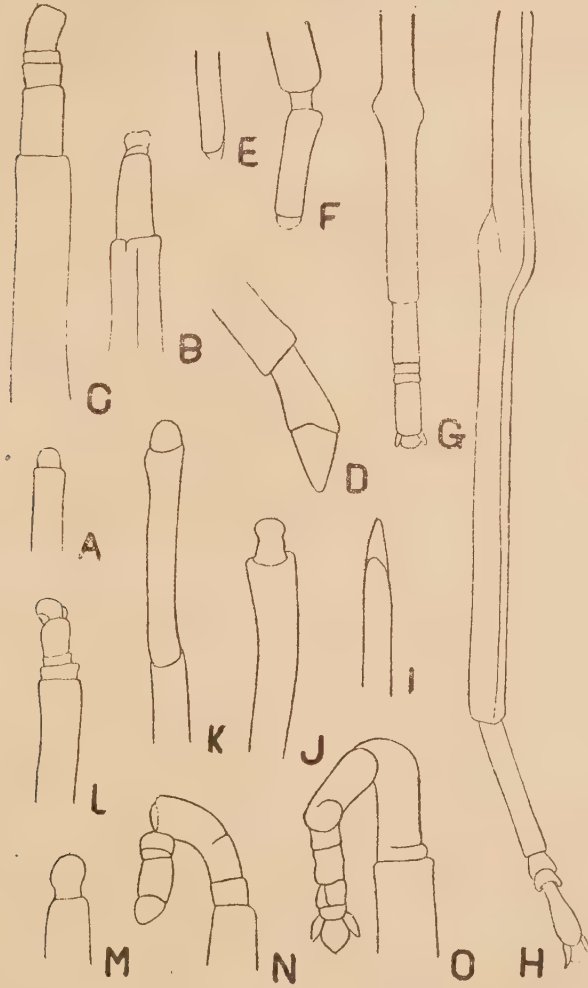


Fig. 20. Abnormal regenerates of *Phraortes kumamotoensis*.

A-C: No. 79 D: No. 22 E-G: No. 3 H: No. 24

I-L: No. 12 M-O: No. 11.

base of the former. No. M 501 (Fig. 21, E)—The left-hand regenerate mid-leg of a male larva was amputated from the trochantero-femoral suture in the third instar. After the fourth

ecdysis a very curious regenerate appeared. The regenerate was biramous, one branch was short and provided with a horn-like projection near the apex, while the other was long, narrowed towards the apex, to which one small segment was attached.

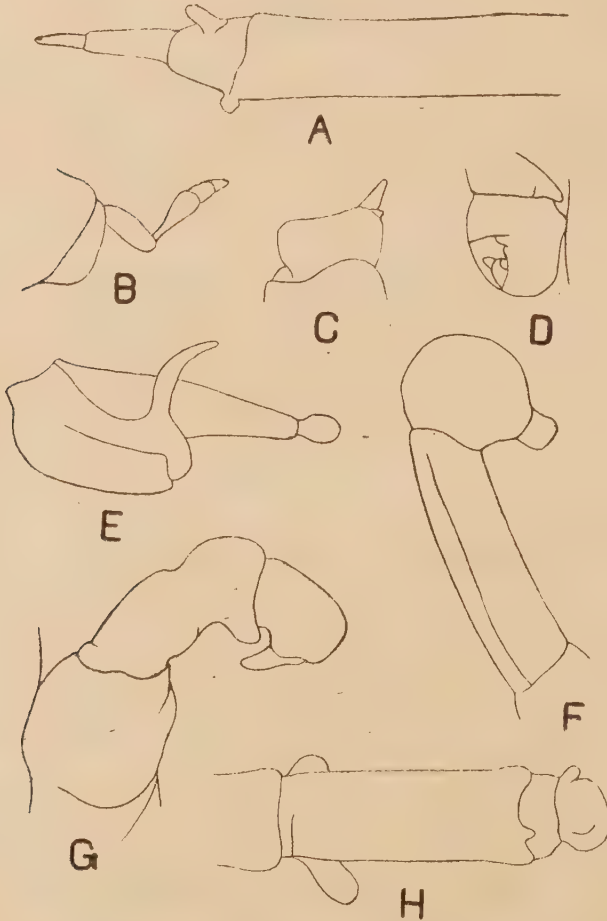


Fig. 21 Abnormal regenerates of *Phraortes kumamotoensis*.

A: No. 300A B: No. 459 C: No. 215Aa D: No. 201Aa

E: No. M501 F: No. 220C G: No. BC H: No. 300B.

11. Triplication of the regenerate. No. R 210 Bb (Fig. 17, A, B, C, D)—The right-hand mid-femur of a newly hatched larva was amputated at the middle. In the third ecdysis a very curious

regenerate appeared. The tibia was short, about twice as long as broad and slightly narrower than the basitarsus. The basitarsus

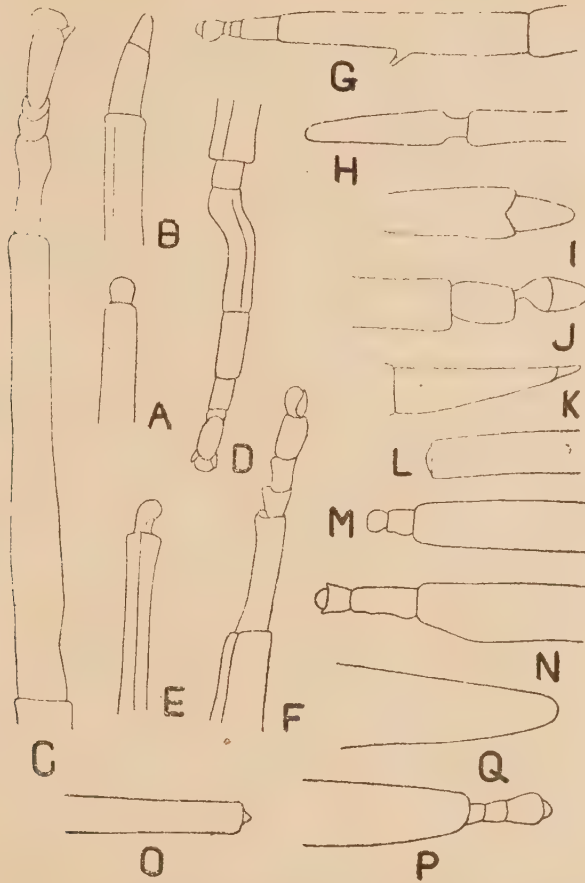


Fig. 22. Abnormal regenerates of *Phraortes kumamotoensis*.

A-C: No. 59 D: No. 118 E-F: No. 85 G-H: No. 115
I-K: No. 55 L-N: No. 74E P-Q: No. 71.

was about as long as the tibia, cylindrical and provided with three separated branches. One was two-segmented but the other two were three-segmented. The apex of the basitarsus was nearly flat. After the next ecdysis the tibia became much longer and the basitarsus was very much constricted at the base. The central tarsal branch was very much prolonged and became four-segment-

ed with ordinary claws at the apex. The basal segment of all the branches was very long and narrowed apically. No. C 220

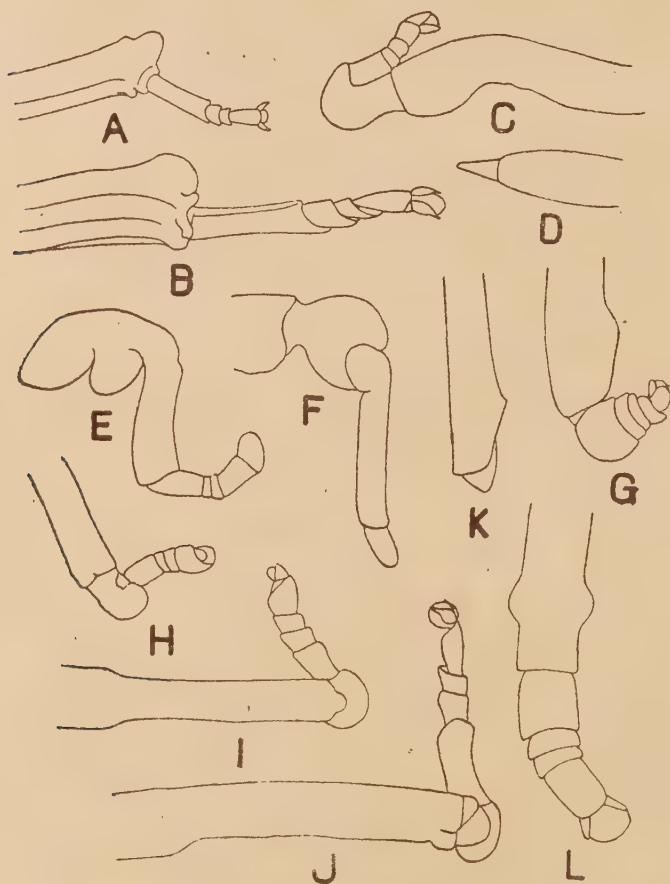


Fig. 23. Abnormal regenerates of *Phraortes kumamotoensis*.

A-B: No. 13 C-D: No. 34 E-F: No. 41 G: No. 38

H-J: No. 14 K-L: No. 24.

(Fig. 17, E, F, G)—The left-hand fore femur of a female larva was amputated at the middle point in the first instar. In the fourth instar a curious regenerate appeared. The basitarsus was as long as the tibia, cylindrical with a longitudinal ridge. Very interesting was the shape of the apical part of the basitarsus. The apex of the basitarsus was strikingly enlarged with three sets of distal

segments. Two of them were not subdivided, but one was three-segmented. In the next instar the basitarsus was strikingly prolonged, its basal half became narrower, and there was seen a tubercle at the middle of the upper portion. All the groups of distal tarsal segments were then composed of four segments. In the course of the following ecdysis these three sets of tarsal segments disappeared.

12. Segregation of the tarsus from the tibia. No. E 220 (Fig. 18, E)—The left-hand mid-leg of a female larva was cut at the apex of the femur in the first instar. After the third ecdysis a curious phenomenon occurred. The tibia was regenerated, but it was very much reduced in size, having been represented by a plate and attached to the oblique apex of the femur. A tetramerous tarsus was attached directly to the femur. Thus the tarsus was completely segregated from the tibia.

13. Shortening of the regenerate tibia. When the femur is amputated at any point except at the trochantero-femoral suture, a shortening of the regenerate tibia will be observed very often. And such a shortening sometimes causes the recurvation of the more distal portion. No. 13 (Fig. 23, A, B) No. 14 (Fig. 23, H, I, J), No. 38 (Fig. 23, G), No. E220 (Fig. 19, D, E), No. 459 (Fig. 21, B), and No. Bc 3 (Fig. 21, G).

14. Formation of an unknown segment or a patella between the regenerate femur and tibia. No. 3 (Fig. 20, F), No. 11 (Fig. 20, N), and No. 118 (Fig. 22, D). This phenomenon seems to demonstrate a lower grade of differentiation of the tibial segment of the present insect.

F. The Effect of the Regenerating Legs upon the Normally Developing Legs

In this chapter I make an effort to find the variation of a gradient within the legs themselves and endeavour to detect, whether the regeneration of one or more legs cause any apparent effect upon the growth of the legs either anterior, posterior or opposite to them. For this purpose the proportion between the segments and the legs as a whole measured in both regenerating and control legs, *i.e.* the length of each segment in one leg was

calculated as a percentage to the sum of the length of the femur and tibia of the same leg, as in the experiments made by DIXEY and GARDINER (1934), TAZELLAR (1938) and YASUMATSU (1938).

The value of $\frac{\text{length of femur (or tibia)}}{\text{total length}} \times 100$ was plotted

against the age. About 37 individuals were selected at random among a large number of the material for this investigation.

1. Descriptions of the Results

Control or normally developing individuals. In fore legs the relative length of the femur is larger than that of the tibia through all stadia; in the male, however, a larger relative length of the tibia is seen in the adult stage. In mid-legs the relative length of the femur and tibia take a same value in both the first and adult (δ) stages; in the second, sixth and adult (φ) stages the relative length of the femur is larger than that of the tibia; in the third, fourth and fifth stadia the relative length of the tibia is larger than that of the femur. In hind legs the relative length of the tibia is larger than that of the femur throughout all stadia.

No. 3, φ (Fig. 24, No. 3: 1—Hind legs, 2—Right-hand (regenerating) mid-leg, 3—Left-hand mid-leg, 4—Fore legs).

In fore legs the relative length of the femur is larger than that of the tibia in earlier stadia, and the relation becomes gradually reverse towards the end of the growth. This phenomenon may be regarded as the effect of the regenerating mid-leg. In the left-hand mid-leg a slight temporary change of the relative length of the femur is seen in the later stadia. In the regenerating (right-hand) mid-leg the fluctuation of the relative length of the femur or tibia is very irregular. In hind legs the relative length of the tibia or femur is almost equal to that of the control insects. This may indicate that the effect of the regenerating leg upon the normally developing legs is negative.

No. 4, φ (Fig. 24, No. 4: 1—Hind legs, 2—Right-hand mid-leg, 3—Left-hand (regenerating) mid-leg, 4—Fore legs).

In fore legs the relative length of the tibia is larger than that of the femur in the two last stadia. In the left-hand (regenerating) mid-leg the change of the proportional length of the femur or

tibia is very distinct. In the right-hand mid-leg a slight temporary change of the relative length of the femur or tibia is seen throughout the stadia. In hind legs the relative length of the tibia is much larger than that of the femur as in the normal case.

No. 5, ♂ (Fig. 24, No. 5: 1—Right-hand (regenerating) hind leg, 2—Left-hand hind leg, 3—Mid-legs, 4—Fore legs).

In fore legs the change of the proportional length of the femur or tibia is seen as in the normal case. The fact may indicate that the regeneration of the hind legs does not influence the normal growth of the fore legs. In mid-legs a slight temporary change of the relative length of the femur or tibia is seen throughout all the stadia. In the left-hand hind leg a distinct temporary change of the proportional length of the tibia or femur is seen throughout all the stadia. In the right-hand (regenerating) hind leg the proportional length of the femur and tibia takes the same value.

No. 6, ♀ (Fig. 24, No. 6: 1—Right-hand^{*} hind leg, 2—Left-hand (regenerating) hind leg, 3—Mid-legs, 4—Fore legs).

In fore legs the temporary change of the relative length of the femur or tibia is very distinct. In mid-legs the proportional length of the femur is larger than that of the tibia throughout all the stadia, contrary to the normal case. In the left-hand (regenerating) hind leg the change of the relative length of the femur or tibia is distinct. In the right-hand hind leg the effect of the regenerating leg is very distinct in three earlier stadia.

No. 10, ♀ (Fig. 24, No. 10: 1—Right-hand (regenerating) hind leg, 2—Left-hand (regenerating) hind leg, 3—Mid-legs, 4—Fore legs).

In fore and mid-legs the temporary change of the proportional length of the femur or tibia is fairly well recognizable. In hind (regenerating) legs the change is much more distinct.

No. 12, ♂ (Fig. 24, No. 12: 1—Hind legs, 2—Mid-legs, 3—Right-hand (regenerating) fore leg, 4—Left-hand fore leg).

In each of the left-hand fore leg and both the mid-legs the temporary change of the proportional length of the femur or tibia is well seen. In the right-hand (regenerating) fore leg the proportional length of the femur is larger than that of the tibia. It must be noted that the relative length of the femur or tibia in hind legs is not influenced by the regenerating growth of the fore legs.

No. 22, ♀ (Fig. 24, No. 22: 1—Right-hand (regenerating) hind leg, 2—Left-hand (regenerating) hind leg, 3—Mid-legs, 4—Fore legs).

In fore and mid-legs the effect of the regenerating hind legs upon the proportional length of the femur or tibia is very distinct. In the right-hand hind leg there cannot be recognizable any influence of the regenerating leg of the opposite side upon the relative length of the femur or tibia of the former.

No. 23, ♂ (Fig. 24, No. 23: 1—Hind legs, 2—Mid-legs, 3—Right-hand (regenerating) fore leg, 4—Left-hand fore leg).

In the left-hand fore leg the effect of the right-hand (regenerating) fore leg upon the proportional length of the femur or tibia is seen, though very slight. Mid-legs are apparently influenced by the abnormal growth of the right-hand fore leg, while no effect upon the relative length of the femur or tibia of the hind legs is recognizable.

No. 24, ♂ (Fig. 24, No. 24: 1—Hind legs, 2—Right-hand (regenerating) mid-leg, 3—Left-hand mid-leg, 4—Fore legs).

In fore legs the change of the proportional length of the femur or tibia is normal. The growth of the left-hand mid-leg is apparently influenced by the abnormal growth of the leg of the opposite side. The effect of the abnormal growth of the mid-leg upon the growth of the hind legs is negligible.

No. 25, ♀ (Fig. 24, No. 25: 1—Right-hand (regenerating) hind leg, 2—Left-hand hind leg, 3—Mid-legs, 4—Fore legs).

In fore legs the relative length of the femur or tibia is normal and not at all influenced by the regenerating hind leg. In mid-legs the temporary change of the proportional length of the femur or tibia is seen. The growth of the left-hand hind leg seems to be independent of the abnormal growth of the right-hand leg.

No. 33, ♀ (Fig. 24, No. 33: 1—Right-hand (regenerating) hind leg, 2—Left-hand hind leg, 3—Mid-legs, 4—Fore legs).

The growth of the mid-legs is slightly abnormal.

No. 44, ♂ (Fig. 24, No. 44: 1—Right-hand (regenerating) hind leg, 2—Left-hand (regenerating) hind leg, 3—Mid-legs, 4—Fore legs).

The effect of the regenerating hind legs upon the growth of the mid-legs is recognizable, but that upon the proportional length of the femur or tibia of the fore legs is almost negligible.

No. 47, ♀ (Fig. 24, No. 47: 1—Hind legs, 2—Right-hand (re-

generating) mid-leg, 3—Left-hand (regenerating) mid-leg, 4—Fore legs).

The regenerating mid-legs do not influence the relative length of the femur or tibia of the fore legs. In the left-hand mid-leg the temporary change of the relative length is seen. In hind legs the proportional length of the femur or tibia is exactly same as that of the control individuals. Here also the abnormal growth of the mid-leg does not effect the growth of the legs situated just posterior to it.

No. 48, ♂ (Fig. 24, No. 48: 1—Right-hand hind leg, 2—Left-hand (regenerating) hind leg, 3—Mid-legs, 4—Fore legs).

In fore legs the proportional length of the femur is distinctly larger than that of the tibia. The growth of the mid-legs is distinctly influenced by the abnormal growth of the left-hand hind leg. It is to be noted that the right-hand hind leg is not at all influenced by the abnormal growth of the leg of the opposite side.

No. 56, ♀ (Fig. 24, No. 56: 1—Right-hand hind leg, 2—Left-hand (regenerating) hind leg, 3—Mid-legs, 4—Fore legs).

No effect of the regenerating hind leg is seen in the growth of the fore legs. The temporary change of the relative length of the femur or tibia of the mid-legs is quite apparent. In this case the growth of the right-hand (normal) hind leg is distinctly influenced by the growth of the left-hand (regenerating) hind leg, though only in the last stadium.

No. 57, ♂ (Fig. 24, No. 57: 1—Hind legs, 2—Mid-legs, 3—Right-hand (regenerating) fore leg, 4—Left-hand fore leg).

The growth of the left-hand fore leg is quite normal. In this case the effect of the growth of the abnormal leg of the opposite side is entirely negative in the growth of the normal leg. Further the proportional length of the segments of the regenerating fore leg is nearly equal to that of the normal one. The effect of the regenerating fore leg upon the growth of the mid-legs is very large, and the change of the proportional length is also very irregular in nature. As in the case of No. 23, ♂, the growth of the hind legs is independent of the growth of the regenerating fore leg.

No. 59, ♂ (Fig. 24, no. 59: 1—Hind legs, 2—Right-hand (regenerating) mid-leg, 3—Left-hand mid-leg, 4—Fore legs).

The growth of the fore legs is of a typical one. The growth of the left-hand mid-leg is apparently influenced by the growth of the regenerating right-hand mid-leg. In hind legs the relative length of the tibia is larger than that of the femur, and growth is never influenced by the legs just anterior to them.

No. 62, ♂ (Fig. 24, No. 62: 1—Hind legs, 2—Right-hand (regenerating) mid-leg, 3—Left-hand mid-leg, 4—Fore legs).

The growth of the right-hand fore leg is remarkably influenced by the regenerating fore leg at the sixth stadium, though the proportional length of the femur is larger than that of the tibia throughout all the stadia. The growth of the mid-legs is apparently changed by the effect of the regenerating anterior leg. The growth of the hind legs is an ideal one as in the case No. 59, ♂. No. 103, ♀ (Fig. 24, No. 103: 1—Hind legs, 2—Right-hand (regenerating) mid-leg, 3—Left-hand mid-leg, 4—Fore legs).

The growth of the left-hand mid-legs is moderately influenced by the regenerating right-hand mid-leg. The growth of the hind legs is of an ideal one.

No. 30, ♂ (Fig. 24, No. 30: 1—Right-hand hind leg, 2—Left-hand (regenerating) hind leg, 3—Right-hand (regenerating) mid-leg, 4—Left-hand mid-leg, 5—Fore legs).

The growth of the fore legs is normal except in the last stage. In the left-hand mid-leg the temporary change of the proportional length of the segments is seen. The change of the proportional length of the segments is not visible both in the second and third stadia in the regenerating legs. In hind legs the effect of the two regenerating legs is completely negative.

No. 34, ♂ (Fig. 24, No. 34: 1—Hind legs, 2—Right-hand (regenerating) mid-leg, 3—Left-hand mid-leg, 4—Right-hand (regenerating) fore leg, 5—Left-hand fore leg).

In spite of the two regenerating legs, the growth of the left-hand fore leg is quite normal. The proportional length of the segments of the right-hand fore leg tends to reach the normal condition with successive ages. The growth of the left-hand mid-leg is abnormal. In hind legs the temporary change of the relative length of the segments is seen very slightly at the third and fourth stadia.

No. 35, ♂ (Fig. 24, No. 35: 1—Right-hand hind leg, 2—Left-hand

(regenerating) hind leg, 3—Right-hand (regenerating) mid-leg, 4—Left-hand mid-leg, 5—Fore legs).

The growth of the fore legs is almost normal, but that of the left-hand mid-leg is apparently influenced by either or both of the abnormally developing legs. The growth of the hind legs is perfectly normal.

No. 36, ♀ (Fig. 24, No. 36: 1—Hind legs, 2—Mid-(regenerating) legs, 3—Right-hand fore leg, 4—Left-hand (regenerating) fore leg).

In the right-hand fore leg the proportional length of the segments is distinctly affected by the left-hand (regenerating) fore leg. In the hind legs the growth is suddenly influenced by the regenerating mid-legs after the fourth instar.

No. 45, ♂ (Fig. 24, No. 45: 1—Right-hand (regenerating) hind leg, 2—Left-hand hind leg, 3—Right-hand mid-leg, 4—Left-hand (regenerating) mid-leg, 5—Fore legs).

The growth of the fore legs is normal and not influenced by the regenerating mid-leg. The left-hand mid-leg is strongly influenced by the regenerating leg of the opposite side. In the left-hand hind leg the relative length of the tibia is distinctly larger than that of the femur as in the normal case. In the right-hand (regenerating) leg the temporary change of the proportional length of the segments is seen in the earlier stadia, but the same in the two last stadia is normal.

No. 69 (Fig. 24, No. 69: 1—Right-hand (regenerating) hind leg, 2—Left hand hind leg, 3—Mid-legs, 4—Right-hand fore leg, 5—Left-hand (regenerating) fore leg).

In this individual only the growth of the left-hand hind legs is normal.

No. 65 (Fig. 24, No. 65: 1—Right-hand (regenerating) hind leg, 2—Left-hand hind leg, 3—Right-hand mid-leg, 4—Left-hand (regenerating) mid-leg, 5—Fore legs).

In fore legs the proportional length of the femur is larger than that of the tibia as in the normal case. In the right-hand mid-leg the relative length of the tibia is larger than that of the femur in the three later stadia as in the normal case, and the effect of the regenerating leg of the opposite side is distinct only at the second instar. In the left-hand hind leg the growth is not influenced by the regenerating right-hand hind leg, in which the temporary change of the proportional length is seen.

No. 66 (Fig. 24, No. 66: 1—Hind legs, 2—Right-hand mid-leg, 3—Left-hand (regenerating) mid-leg, 4—Right-hand (regenerating) fore leg, 5—Left-hand fore leg).

The growth of the left-hand fore leg may be regarded as normal. The growth of the right-hand mid-leg and the hind legs is apparently influenced by the regenerating (left-hand) mid-leg.

No. 54b, ♀ (Fig. 24, No. 54b: 1—Regenerating hind legs, 2—Mid-legs, 3—Fore legs).

The growth of the mid-legs is not influenced by the regenerating hind legs. The temporary change of the proportional length in fore legs is questionable at the fifth stage. The temporary change of the relative length of the segments of the regenerating hind legs is irregular throughout all the stadia.

No. 58b, ♀ (Fig. 24, No. 58b: 1—Hind legs, 2—Regenerating mid-legs, 3—Fore legs).

In fore legs the proportional length of the femur is larger than that of the tibia as in the normal case. In the regenerating mid-legs the proportional length of the femur and tibia takes the same value in the fourth and fifth stadia, and the growth in the later stadia is normal. The growth of the hind legs seems to be affected by the regenerating mid-legs.

No. 68 (Fig. 24, No. 68: 1—Right-hand (regenerating) hind leg, 2—Left-hand hind leg, 3—Mid-legs, 4—Fore legs).

The growth of the left-hand hind leg is normal. The growth of the fore and mid-legs seems to be influenced by the regenerating right-hand hind leg.

No. 86 (Fig. 24, No. 86: 1—Hind legs, 2—Mid-legs, 3—Right-hand fore leg, 4—Left-hand (regenerating) fore leg).

In the right-hand fore leg the temporary change of the proportional length is large. Apparently its growth is influenced by the left-hand (regenerating) fore leg. The growth of the mid-legs seems to be influenced by the regenerating anterior leg very slightly. The growth of the hind legs may be said as normal.

No. 87, ♀ (Fig. 24, No. 87: 1—Hind legs, 2—Right-hand mid-leg, 3—Left-hand (regenerating) mid-leg, 4—Fore legs).

In fore legs the temporary change of the proportional length is seen. The effect of the regenerating mid-leg upon the fore legs is apparent. The growth of the right-hand mid-leg is also influenced by the regenerating leg of the opposite side. The growth

of the hind legs is influenced by the regenerating mid-leg only in the fifth stadium.

No. 75 (Fig. 24, No. 75: 1—Hind legs, 2—Right-hand (regenerating) mid-leg, 3—Left-hand mid-leg, 4—Fore legs).

In the growth of the fore legs the effect of the regenerating right-hand mid-leg is completely negative. In the left-hand mid-leg the temporary change of the proportional length of the segments is conspicuous, and the leg may apparently be influenced by the regenerating right-hand mid-leg. The growth of the hind legs is of a typical one.

No. 63 (Fig. 24, No. 63: 1—Right-hand (regenerating hind leg, 2—Left-hand hind leg, 3—Mid-legs, 4—Fore legs).

In fore legs the relative length of the femur is larger than that of the tibia throughout all the stadia, and the growth is independent of the regenerating right-hand hind leg. The effect of the regenerating hind leg upon the growth of the mid-legs is conspicuous. The growth of the left-hand hind leg is of a typical one. In the right-hand regenerating hind leg the temporary change of the proportional length is very distinct.

No. 79, ♀ (Fig. 24, No. 79: 1—Hind legs, 2—Mid-legs, 3—Right-hand (regenerating) fore leg, 4—Left-hand fore leg).

The growth of the left-hand fore leg is almost unaffected by the regenerating leg of the opposite side. In all the mid- and hind legs a very slight temporary change of the proportional length is seen.

No. 80, ♂ (Fig. 24, No. 80: 1—Right-hand (regenerating) hind leg, 2—Left-hand hind leg, 3—Mid-legs, 4—Fore legs).

The growth of the fore legs is almost normal. In mid-legs the temporary change of the relative length is fairly well pronounced. The growth of the left-hand hind leg is of a typical one.

Change of the proportional length of the segments in regenerating legs.

In regenerating fore legs the following three cases were observed.

1. The proportional length of the femur is larger than that of the tibia through all the stadia as in the case of normal legs.

2. The proportional length of the segments is normal until the last stadium but one.

3. The proportional length of the femur is smaller than that of tibia until the third stadium, then from the fourth it becomes larger as in normal case.

In regenerating mid-legs the following four cases were observed.

1. The proportional length of the femur is abnormal at two earlier stadia, then it becomes normal from the third stadium.

2. The proportional length of the segments is as in the case of the first, but it becomes normal from the sixth stadium.

3. The proportional length of the segments is abnormal until the last stadium but one.

4. The proportional length of the segments is abnormal through all the stadia. This case is most abundant.

In regenerating hind legs the following six cases were observed.

1. The proportional length of the segments is abnormal until the last stadium but one.

2. The proportional length of the segments is normal only from the sixth stadium.

3. The proportional length of the segments is abnormal through the four earlier stadia, then it becomes normal from the fifth stadium.

4. The proportional length of the segments is abnormal through all the stadia. Most abundant is this case.

5. The proportional length of the tibia is larger than that of the femur through all the stadia.

6. The proportional length of the segments is normal, then it becomes abnormal only from the sixth stadium.

Influence of the regenerating leg upon normally developing legs.

Influence of the regenerating fore leg upon normally developing legs.

The following eight cases were observed.

1. The regeneration of a fore leg influences the growth of the other fore leg (three examples).

2. The regeneration of a fore leg gives no influence upon the growth of the other fore leg (one example).

3. The regeneration of a fore leg gives influence upon the growth of the other fore leg only in the earlier stadia (one example).

4. The regeneration of a fore leg gives influence upon the

growth of the other fore leg only in the last stadium (one example).

5. The regeneration of a fore leg gives distinct influence upon the growth of the mid-legs (six examples).

6. The regeneration of a fore leg gives no effect upon the growth of the hind legs (three examples).

7. The regeneration of a fore leg gives practically no influence upon the growth of the hind legs (two examples).

8. The regeneration of a fore leg gives some influence upon the growth of the hind legs in several stadia (one example).
Influence of the regenerating mid-leg upon normally developing legs.
The following eight cases were observed.

1. The regeneration of a mid-leg gives no influence upon the growth of the fore legs (one example).

2. The regeneration of a mid-leg gives distinct influence upon the growth of the fore legs (four examples).

3. The regeneration of a mid-leg gives some effect upon the growth of the fore legs only in the last stadium (three examples).

4. The regeneration of a mid-leg gives distinct influence upon the growth of the mid-leg opposite to the former (seven examples).

5. The regeneration of a mid-leg gives some effect upon the growth of the mid-leg opposite to the former only in earlier stadia (one example).

6. The regeneration of a mid-leg gives no influence upon the growth of the hind legs (one example).

7. The regeneration of a mid-leg gives almost no effect upon the growth of the hind legs (five examples).

8. The regeneration of a mid-leg gives some effect upon the growth of the hind legs in several stadia (two examples).
Influence of the regenerating hind leg upon normally developing legs.
The following nine cases were observed.

1. The regeneration of a hind leg gives no effect upon the growth of the fore legs (four examples).

2. The regeneration of a hind leg gives distinct influence upon the growth of the fore legs (three examples).

3. The regeneration of a hind leg gives some effect upon the growth of the fore legs only in earlier stadia (four examples).

4. The regeneration of a hind leg gives distinct influence upon the growth of the mid-legs (ten examples).

5. The regeneration of a hind leg gives some influence upon the growth of the mid-legs in earlier stadia (two examples).

6. The regeneration of a hind leg gives no influence upon the growth of the hind leg opposite to the former (four examples).

7. The regeneration of a hind leg gives almost no influence upon the growth of the hind leg opposite to the former (two examples).

8. The regeneration of a hind leg gives some effect upon the growth of the hind leg opposite to the former in earlier stadia (six examples).

9. The regeneration of a hind leg gives some effect upon the growth of the hind leg opposite to the former in both earlier and later stadia (one example).

Influence of two or three regenerating legs upon the normally developing legs. The following ten cases were observed.

1. The regeneration of a fore leg and mid-legs gives distinct influence upon the growth of the other fore leg and the hind legs (one example).

2. The regeneration of a fore leg and a mid-leg gives distinct influence upon the growth of the hind legs and the other mid-leg in earlier stadia, and it also gives some effect upon the growth of the other fore leg in later stadia (one example).

3. The regeneration of a fore leg and a mid-leg gives influence upon the growth of the other fore leg in the last stadium and distinct effect upon the growth of the other mid-leg, and it also gives some influence upon the growth of the hind legs in some stadia (one example).

4. The regeneration of the two mid-legs gives no effect upon the growth of the fore legs and more or less slight influence upon the growth of the hind legs (one example).

5. The regeneration of a mid-leg and a hind leg gives no influence upon the growth of the fore legs and distinct effect upon the growth of the other mid-leg and also upon that of the other hind leg only in the last stadium (one example).

6. The regeneration of a mid-leg and a hind leg gives influence upon the growth of the fore legs in the last stadium and some influence upon the growth of the other mid-leg and no effect upon the growth of the other hind leg (one example).

7. The regeneration of a mid-leg and a hind leg gives no

influence upon the growth of the fore legs, and distinct influence upon the growth of the other mid-leg and some effect upon the growth of the other hind leg in earlier stadia (one example).

8. The regeneration of a mid-leg and a hind leg gives no influence upon the growth of the fore legs, distinct effect upon the growth of the other mid-leg in earlier stadia and distinct influence upon the growth of the other hind leg (one example).

9. The regeneration of a fore leg and a hind leg gives influence upon the growth of the other fore leg and the mid-legs, but gives no effect upon the growth of the other hind leg (one example).

10. The regeneration of the two hind legs gives no influence upon the growth of the fore and mid-legs (one example).

Table 21. Mean measurements of normal fore legs.

Instar	Femur		Tibia		Total length
	Length	Femur total l. per cent	Length	Tibia total l. per cent	
I	3.4	51.51	3.2	48.49	6.6
II	5.5	53.39	4.8	46.61	10.3
III	7.8	52.34	7.1	47.66	14.9
IV	10.5	51.98	9.7	48.02	20.2
V ♂	15.0	50.33	14.8	49.67	29.8
V ♀	13.3	51.15	12.7	48.85	26.0
VI ♂	21.0	47.95	22.8	52.05	43.8
VI ♀	16.7	51.22	15.9	48.79	32.6
VII	21.9	50.22	21.7	49.78	43.6

Table 22. Mean measurements of normal mid-legs.

Instar	Femur		Tibia		Total length
	Length	Femur total l. per cent	Length	Tibia total l. per cent	
I	2.8	50.00	2.8	50.00	4.6
II	4.3	50.58	4.2	49.42	8.5
III	5.9	49.58	6.0	50.42	11.9
IV	7.8	49.06	8.1	50.94	15.9
V ♂	11.0	49.77	11.1	50.23	22.1
V ♀	9.9	49.74	10.0	50.26	19.9
VI ♂	16.0	50.00	16.0	50.00	32.0
VI ♀	12.7	51.01	12.2	48.99	24.0
VII	16.5	51.72	15.4	48.18	31.9

Table 23. Mean measurements of normal hind legs.

Instar	Femur		Tibia		Total length
	Length	Femur total l. per cent	Length	Tibia total l. per cent	
I	3.0	46.16	3.5	53.84	6.5
II	4.8	48.00	5.2	52.00	10.0
III	6.6	47.49	7.3	52.51	13.9
IV	8.9	48.37	9.5	51.63	18.4
V ♂	12.5	48.64	13.2	51.36	25.7
V ♀	10.7	45.73	12.7	54.27	23.4
VI ♂	18.6	47.94	20.2	52.06	38.8
VI ♀	14.1	49.03	14.6	50.87	28.7
VII	18.7	49.09	19.4	50.91	38.1

Table 24₁. Measurements of regenerating and normal legs, 1.

No. 3 Instar	Fore leg			Mid - leg			Hind leg		
	F t. l. p.	T t. l. p.	Total length	F t. l. p.	T t. l. p.	Total length	F t. l. p.	T t. l. p.	Total length
I	56.93	43.07	7.08	50.00	50.00	6.00	47.80	52.20	6.80
II	52.56	47.44	10.75	48.84	51.16	8.60	57.62	52.38	10.50
III	52.64	47.36	15.20	50.80	49.20	12.60	48.45	51.55	14.45
IV	51.50	48.50	20.00	49.36	50.64	15.80	48.13	51.87	17.35
V	50.00	50.00	26.00	49.51	50.49	20.20	48.65	51.35	22.20
VI	49.56	50.44	33.50	48.96	50.94	25.70	50.70	49.30	28.50
VII	48.79	51.21	43.05	49.85	50.15	31.90	49.19	50.81	36.70

Table 24₂. Measurements of regenerating and normal legs, 2.

No. 4 Instar	Fore leg			Mid - leg			Hind leg		
	F t. l. p.	T t. l. p.	Total length	F t. l. p.	T t. l. p.	Total length	F t. l. p.	T t. l. p.	Total length
I	52.15	57.85	7.00						
II	52.05	47.55	11.25						
III	51.62	48.38	15.50						
IV	52.24	47.76	20.10	50.00	50.00	0.80	47.78	52.22	7.18
V	51.44	48.56	26.15	59.10	40.90	2.20	47.45	52.55	10.75
VI	49.78	50.22	33.15	68.19	31.81	5.50	46.67	53.33	15.00
VII	48.47	51.53	42.30	63.31	36.69	10.90	47.47	52.53	18.75
				55.56	44.44	18.00	46.42	53.58	23.70
				50.57	49.43	26.50	48.98	51.02	29.40
							48.03	51.97	38.50

Table 24_r. Measurements of regenerating and normal legs, 5.[illegible]Table 24_g. Measurements of regenerating and normal legs, 6.

No. 12 Instar	Fore leg				Mid - leg				Hind leg			
	F t. l. p.	T t. l. p.	Total length	F t. l. p.	T t. l. p.	Total length	F t. l. p.	T t. l. p.	Total length	F t. l. p.	T t. l. p.	Total length
I	50.76	49.24	6.60	100.00	1.90		49.10	50.90	5.54	46.16	53.84	6.50
II	50.99	49.01	10.20	100.00	1.30		47.31	52.69	8.35	48.08	51.92	10.40
III	53.13	46.87	16.00	77.78	2.25		49.33	50.67	12.55	48.62	51.38	14.40
IV	51.66	48.34	21.10	85.72	14.28		50.00	50.00	16.00	49.47	50.53	18.80
V	49.34	50.66	30.00	72.22	27.78	9.00	48.56	51.44	20.80	48.00	52.00	25.00
VI	47.85	52.15	44.10	63.80	36.17	18.80	51.29	48.71	31.20	48.65	51.35	37.00

Table 24₉. Measurements of regenerating and normal legs, 9.

No. 24 Instar	Fore leg					Mid - leg					Hind leg				
	F		T		Total length	F		T		Total length	F		T		Total length
	t. l. p.	t. l. p.	t. l. p.	t. l. p.		t. l. p.	t. l. p.	t. l. p.	t. l. p.		t. l. p.	t. l. p.	t. l. p.	t. l. p.	
I	53.08	46.92	6.82			52.18	47.82	5.75	63.22	36.78	4.35	46.97	53.03	6.60	
II	51.46	48.54	10.30			48.20	51.80	8.30	66.67	33.33	6.00	48.28	51.72	10.15	
III	52.45	47.55	14.30			50.00	50.00	11.60	68.36	31.64	7.90	47.73	52.27	13.20	
IV	52.07	47.93	17.80			50.00	50.00	15.00	68.63	31.37	10.20	50.00	50.00	16.80	
V	51.89	48.11	23.90			50.00	50.90	18.00	57.70	42.30	15.40	49.55	50.45	21.80	
VI	50.82	49.18	30.50			50.43	49.57	23.80	56.41	43.59	19.50	49.10	50.90	27.50	

Table 24₁₀. Measurements of regenerating and normal legs, 10.

No. 25 Instar	Fore leg					Mid - leg					Hind leg				
	F		T		Total length	F		T		Total length	F		T		Total length
	t. l. p.	t. l. p.	t. l. p.	t. l. p.		t. l. p.	t. l. p.	t. l. p.	t. l. p.		t. l. p.	t. l. p.	t. l. p.	t. l. p.	
II	51.78	48.22	10.45			47.81	52.19	9.10	47.58	52.42	10.30	100.00	0.00	0.50	
III	51.73	48.27	14.50			47.83	52.18	11.50	49.65	50.35	13.90	46.52	53.48	2.15	
IV	50.93	49.07	18.85			50.16	49.84	14.45	49.11	50.89	16.90	51.29	48.71	7.80	
V	52.00	48.00	25.00			48.65	51.35	18.50	48.89	51.11	22.50	50.00	50.00	15.00	
VI	51.36	48.64	33.30			50.81	49.19	25.50	48.28	51.72	29.00	50.00	50.00	23.00	
VII	50.00	50.00	40.00			50.00	50.00	30.00	49.87	50.13	35.90	54.70	45.30	30.90	

Table 24₁₁. Measurements of regenerating and normal legs, 11.

No. 33 Instar	Fore leg			Mid - leg			Hind leg		
	F t. l. p.	T t. l. p.	Total length	F t. l. p.	T t. l. p.	Total length	F t. l. p.	T t. l. p.	Total length
III	53.71	46.29	16.20	49.41	50.59	12.55	50.00	50.00	1.20
IV	52.89	47.11	22.50	51.22	48.78	16.40	50.00	50.00	4.00
V	51.45	48.55	27.60	51.22	48.78	20.50	50.00	50.00	14.00
VI	50.82	49.18	36.60	50.55	49.45	27.30	48.94	51.06	23.50
VII	49.46	50.54	45.50	50.00	50.00	32.00	46.02	53.98	32.60

Table 24₁₂. Measurements of regenerating and normal legs, 12.

No. 44 Instar	Fore leg			Mid - leg			Hind leg		
	F t. l. p.	T t. l. p.	Total length	F t. l. p.	T t. l. p.	Total length	F t. l. p.	T t. l. p.	Total length
I	53.47	46.53	6.92	50.00	50.00	5.50	50.00	50.00	0.80
II	52.84	47.16	10.60	50.59	49.41	8.50	50.00	50.00	2.00
III	53.34	46.66	15.00	50.42	49.58	12.10	50.00	50.00	2.00
IV									
V	51.33	48.67	26.50	50.30	49.70	19.90	52.71	47.29	14.80
VI	50.60	49.40	33.60	49.39	50.61	24.30	48.00	52.00	25.00

Table 24₁₃. Measurements of regenerating and normal legs, 13.

No. 47 Instar	Fore leg			Mid - leg			Hind leg		
	F	T	Total	F	T	Total	F	T	Total
	t. l. p.	t. l. p.	length	t. l. p.	t. l. p.	length	t. l. p.	t. l. p.	length
I	53.09	46.91	6.65				47.38	52.62	5.70
II	54.63	45.37	10.80	50.00	50.00	1.00	52.33	47.67	8.60
III	51.39	48.61	14.40	47.37	52.63	1.90	49.19	50.81	12.20
IV	51.55	48.45	19.40	53.33	46.67	6.00	50.00	50.00	15.60
V									
VI	52.69	47.31	31.70	51.55	48.45	19.40	51.03	48.97	24.50
VII	50.00	50.00	40.20	50.97	49.03	25.90	50.83	49.17	30.10

Table 24₁₄. Measurements of regenerating and normal legs, 14.

No. 48 Instar	Fore leg			Mid - leg			Hind leg		
	F	T	Total	F	T	Total	F	T	Total
	t. l. p.	t. l. p.	length	t. l. p.	t. l. p.	length	t. l. p.	t. l. p.	length
I	52.64	47.36	6.65	47.37	52.63	5.70			
II	53.71	46.29	10.80	49.72	50.28	8.65	50.00	50.00	1.00
III	52.33	47.67	15.10	49.19	50.81	12.20	50.00	50.00	1.80
IV									
V	51.50	48.50	26.80	50.00	50.00	20.00	73.69	26.31	7.60
VI	50.30	49.70	34.20	51.28	48.62	25.50	69.24	30.76	13.00
							48.29	51.71	23.20
							48.83	51.17	29.70

Table 24₁₅. Measurements of regenerating and normal legs, 15.

No. 56	Fore leg			Mid - leg			Hind leg		
	F t.l.p.	T t.l.p.	Total length	F t.l.p.	T t.l.p.	Total length	F t.l.p.	T t.l.p.	Total length
Instar									
II	56.78	43.13	10.20	48.96	51.04	8.15	50.50	49.50	9.90
III	51.24	48.86	13.65	50.23	49.77	11.35	50.00	48.62	1.50
IV	54.10	45.90	18.30	50.00	50.00	14.00	51.11	48.89	4.50
V	52.49	47.51	24.50	51.36	48.64	18.50	49.67	50.33	15.10
VI	51.62	48.38	31.00	59.03	40.97	28.80	50.21	49.79	24.90
VII	51.21	48.79	39.35	50.09	49.91	29.75	50.00	50.00	33.00
							51.64	48.36	36.80

Table 24₁₆. Measurements of regenerating and normal legs, 16.

No. 57	Fore leg			Mid - leg			Hind leg		
	F t.l.p.	T t.l.p.	Total length	F t.l.p.	T t.l.p.	Total length	F t.l.p.	T t.l.p.	Total length
Instar									
II	53.22	46.78	10.90	100.00	0.00	5.80	47.68	52.32	8.60
III	51.90	48.10	15.80	56.94	43.06	8.36	49.80	50.20	12.15
IV	51.49	48.51	20.20	85.90	14.01	10.70	51.44	48.56	15.65
V	51.43	48.57	28.00	68.43	31.57	19.00	51.66	48.34	21.10
VI	48.80	51.20	41.40	53.53	46.47	35.50	48.23	51.77	32.35
							49.74	50.26	37.40

Table 24_r. Measurements of regenerating and normal legs, 17.

No. 59 Instar	Fore leg						Mid - leg						Hind leg					
	F			T			F			T			F			T		
	t. l. p.	t. l. p.	Total length	t. l. p.	t. l. p.	Total length	t. l. p.	t. l. p.	Total length	t. l. p.	t. l. p.	Total length	t. l. p.	t. l. p.	Total length	t. l. p.	t. l. p.	Total length
II	52.39	47.61	10.50	50.00	50.00	8.80	100.00	100.00	0.00	4.40			47.48	52.52	9.90			
III	53.34	46.66	15.00	48.82	51.18	12.70	94.0	94.0	5.99	5.85			48.91	51.09	13.70			
IV	50.50	49.50	20.20	51.95	48.05	15.40	92.10	92.10	7.80	7.60			49.46	50.54	18.20			
V	50.93	49.07	26.90	51.21	48.79	20.70	68.26	68.26	31.74	12.60			48.29	51.71	23.20			
VI	48.61	51.39	43.00	50.82	49.18	30.50	55.56	55.56	44.44	27.00			50.00	50.00	37.20			

Table 24_s. Measurements of regenerating and normal legs, 18.

No. 62 Instar	Fore leg						Mid - leg						Hind leg					
	F			T			F			T			F			T		
	t. l. p.	t. l. p.	Total length	t. l. p.	t. l. p.	Total length	t. l. p.	t. l. p.	Total length	t. l. p.	t. l. p.	Total length	t. l. p.	t. l. p.	Total length	t. l. p.	t. l. p.	Total length
II	52.39	47.61	10.50	48.27	51.72	8.70	66.67	66.67	33.33	6.00			49.50	50.50	9.90			
III	50.63	49.37	16.00	50.00	50.00	12.00	66.67	66.67	33.33	9.00			50.93	49.07	13.55			
IV	50.73	49.27	20.70	48.49	51.51	16.50	69.30	69.30	30.70	11.40			48.36	51.64	19.15			
V	50.17	49.83	29.09	50.94	49.06	21.40	64.34	64.34	35.66	15.70			49.24	50.76	26.20			
VI	48.19	51.81	38.60	51.37	48.63	29.20	61.54	61.54	38.46	19.50			49.29	50.71	34.90			

Table 24₁₉. Measurements of regenerating and normal legs, 19.

No. 101 Instar	Fore leg				Mid - leg				Hind leg			
	F t.l.p.	T t.l.p.	F t.l.p.	Total length	F t.l.p.	T t.l.p.	F t.l.p.	Total length	F t.l.p.	T t.l.p.	F t.l.p.	Total length
IV			52.48	47.52	19.80	51.53	48.47	14.75	48.87	51.13		17.60
V	40.00	60.00	1.25	50.39	49.61	25.80	51.36	48.64	18.50	48.04	51.96	22.90
VI	53.83	41.17	6.80	59.08	40.92	32.50	52.00	48.00	25.00	48.22	51.78	28.00
VII	53.43	46.57	21.90	50.73	49.27	39.80	51.12	48.88	28.15	48.58	51.42	35.00

Table 24₂₀. Measurements of regenerating and normal legs, 20.

No. 103 Instar	Fore leg				Mid - leg				Hind leg			
	F t.l.p.	T t.l.p.	F t.l.p.	Total length	F t.l.p.	T t.l.p.	F t.l.p.	Total length	F t.l.p.	T t.l.p.	F t.l.p.	Total length
IV	50.23	49.77	22.10	49.46	50.50	18.20			47.62	52.38		21.00
V	50.00	50.00	32.00	49.40	50.60	24.90	53.49	46.51	2.15	48.28	51.72	29.00
VI	47.83	52.17	46.00	48.81	51.19	33.40	44.83	55.17	11.60	48.98	51.02	39.20

Table 24₂₁. Measurements of regenerating and normal legs, 21.

No. 30	Instar	Fore leg			Mid - leg			Hind leg			Total length					
		F t. l. p.	T t. l. p.	Total length	F t. l. p.	T t. l. p.	Total length	F t. l. p.	T t. l. p.	Total length						
	I	53.58	46.42	6.72	50.85	49.15	5.90	0.00	0.00	0.00	0.00	45.26	54.74	6.85		
	II	52.61	47.39	10.55	49.44	50.56	8.90	50.00	50.00	1.00	50.00	46.88	53.12	9.60		
	III	52.42	48.58	14.50	51.73	48.27	11.60	50.00	50.00	3.50	50.00	47.73	52.27	13.20		
	IV															
	V	51.94	48.06	23.30	50.00	50.00	18.00	52.95	48.05	17.00	52.67	47.33	16.90	47.62	52.38	21.00
	VI	52.42	47.52	29.50	51.76	48.24	22.80	54.35	45.65	23.00	50.21	49.79	23.90	50.00	50.00	23.00

Table 24₂₂. Measurements of regenerating and normal legs, 22.

No. 34 Instar	Fore leg					Mid leg					Hind leg				
	F t. l. p.	T t. l. p.	Total length	F t. l. p.	T t. l. p.	Total length	F t. l. p.	T t. l. p.	Total length	F t. l. p.	T t. l. p.	Total length	F t. l. p.	T t. l. p.	Total length
II	53.71	46.29	10.80				50.00	50.00	9.00	0.00	0.00		49.51	50.49	10.10
III	52.17	47.83	16.30	50.00	50.00	1.50	50.00	50.00	13.00	50.00	50.00	1.50	50.00	50.00	14.00
IV	51.41	48.59	21.40	54.45	45.45	4.40	49.11	50.89	16.70	50.00	50.00	4.40	50.00	50.00	19.00
V	51.25	48.75	28.10	51.73	48.27	17.40	50.00	50.00	20.00	48.53	51.47	13.60	48.98	51.02	24.50
VI	49.37	50.63	39.50	49.24	50.76	32.70	50.00	50.00	24.00	52.94	47.36	19.00	48.17	51.83	35.50

Table 24₂₃. Measurements of regenerating and normal legs, 23.

No. 35	Fore leg					Mid - leg					Hind leg				
	F t. l. p.	T t. l. p.	Total length	F t. l. p.	T t. l. p.	Total length	F t. l. p.	T t. l. p.	Total length	F t. l. p.	T t. l. p.	Total length	F t. l. p.	T t. l. p.	Total length
Instar															
II	53.71	46.29	10.80	50.00	50.00	9.00	50.00	50.00	50.00	50.00	50.00	1.20	46.85	53.15	11.10
III	50.32	49.68	15.90	50.00	50.00	13.00	50.00	50.00	50.00	50.00	50.00	4.20	46.67	53.33	15.00
IV	51.62	48.38	21.70	49.11	50.89	16.70	50.00	50.00	50.00	50.00	50.00	4.20	47.50	52.50	19.20
V	52.00	48.00	25.00	50.00	50.00	20.00	48.53	51.47	13.60	52.39	47.61	21.00	47.83	52.17	23.00
VI	51.60	48.40	31.40	50.00	50.00	24.00	52.64	47.36	19.00	52.00	48.00	25.00	48.28	51.72	29.00

Table 24₂₄. Measurements of regenerating and normal legs, 24.

No. 36	Fore leg					Mid - leg					Hind leg				
	F t. l. p.	T t. l. p.	Total length	F t. l. p.	T t. l. p.	Total length	F t. l. p.	T t. l. p.	Total length	F t. l. p.	T t. l. p.	Total length	F t. l. p.	T t. l. p.	Total length
Instar															
II	52.64	47.36	9.50	52.64	47.36	9.50							45.27	54.73	9.50
III	56.34	43.66	14.20	56.34	43.66	14.20							47.12	52.88	12.90
IV				51.07	48.93	18.80	50.00	50.00	1.50				67.19	32.81	12.80
V	50.00	50.00	5.00	51.26	48.74	23.80	52.35	47.65	12.80				64.47	35.53	15.90
VI	50.00	50.00	18.40	49.08	50.92	32.60	50.00	50.00	20.00				61.95	38.05	20.10
VII				49.94	50.06	39.50	50.54	49.46	28.30				60.16	39.84	26.35

Table 24₂₈. Measurements of regenerating and normal legs, 25.

No. 45 Instar	Fore leg				Mid - leg				Hind leg			
	F		T		F		T		F		T	
	t. l. p.	length	t. l. p.	length	t. l. p.	length	t. l. p.	length	t. l. p.	length	t. l. p.	length
I	51.73	48.27	7.25		50.00	6.00	50.00	50.00	50.00	7.40		
II	53.58	46.42	11.20	50.00	50.00	9.60	50.00	54.54	50.00	11.00	50.00	0.70
III	50.32	49.68	15.90	48.08	47.25	12.70	52.75	48.28	51.72	14.50	51.93	2.60
IV												
V	51.73	48.27	29.00	47.35	52.65	18.80	50.70	48.42	51.58	25.20	47.55	20.40
VI	47.87	52.13	42.20	47.72	52.28	30.60	47.72	52.00	52.00	37.50	46.93	35.80

Table 24₂₈. Measurements of regenerating and normal legs, 26.

No. 69 Instar	Fore leg				Mid - leg				Hind leg			
	F		T		F		T		F		T	
	t. l. p.	length	t. l. p.	length	t. l. p.	length	t. l. p.	length	t. l. p.	length	t. l. p.	length
I					52.64	47.36	9.50	8.20	47.93	52.07	9.60	
II					52.39	47.61	14.70	11.50	46.16	53.84	13.00	0.70
III	58.34	41.66	0.60		51.30	51.30	52.02	14.80	46.45	53.55	18.30	5.10
IV	56.37	43.63	5.50	51.30	48.70	19.30	47.98	20.00	46.45	53.55	23.90	17.70
V	50.00	50.00	19.00	48.69	51.32	26.30	50.00	20.00	46.45	53.55	23.90	17.70

Table 24₂₇. Measurements of regenerating and normal legs, 27.

No. 65	Fore leg					Mid - leg					Hind leg				
	F		T		Total length	F		T		Total length	F		T		Total length
	t. l. p.	t. l. p.	t. l. p.	t. l. p.		t. l. p.	t. l. p.	t. l. p.	t. l. p.		t. l. p.	t. l. p.	t. l. p.	t. l. p.	
Instar	52.64	47.36	9.50			48.79	51.21	8.20	45.66	54.34	9.20				
II	52.18	47.82	13.80			49.55	50.45	11.10	47.62	52.38	12.60				0.70
III	51.36	48.64	18.50			48.62	51.38	14.40	47.06	52.94	17.00				4.50
IV	51.22	48.78	24.60			47.90	52.10	19.00	47.89	52.11	21.30				14.60
V															

Table 24₂₈. Measurements of regenerating and normal legs, 28.

No. 66	Fore leg					Mid - leg					Hind leg				
	F		T		Total length	F		T		Total length	F		T		Total length
	t. l. p.	t. l. p.	t. l. p.	t. l. p.		t. l. p.	t. l. p.	t. l. p.	t. l. p.		t. l. p.	t. l. p.	t. l. p.	t. l. p.	
Instar	52.39	47.61	10.50												
II	51.04	48.96	14.50			45.46	54.54	0.55	50.00	50.00	8.00		47.48	52.52	9.90
III	51.22	48.78	20.50			48.72	51.28	3.90	49.02	50.98	15.30		46.57	53.43	13.10
IV	49.83	50.17	28.90			53.58	46.42	16.80	55.56	44.44	20.60		54.05	45.95	16.35
V													53.52	46.48	22.05

Table 24₂₈. Measurements of regenerating and normal legs, 29.

No. 54 b Instar	Fore leg			Mid - leg			Hind leg		
	F	T	Total	F	T	Total	F	T	Total
	t. l. p.	t. l. p.	length	t. l. p.	t. l. p.	length	t. l. p.	t. l. p.	length
III	52.38	47.62	14.70	49.60	50.40	12.30			
IV							50.00	50.00	1.50
V	40.97	59.03	16.60	49.45	50.55	18.20	53.71	46.29	5.40
VI	53.49	46.51	20.10	51.29	48.71	23.40	53.98	46.02	16.30
VII	50.99	49.01	33.15	50.99	49.01	30.60	49.74	50.26	27.95

Table 24₃₀. Measurements of regenerating and normal legs, 30.

No. 58 b Instar	Fore leg			Mid - leg			Hind leg		
	F	T	Total	F	T	Total	F	T	Total
	t. l. p.	t. l. p.	length	t. l. p.	t. l. p.	length	t. l. p.	t. l. p.	length
III	52.71	47.29	14.80				49.24	50.76	13.00
IV				50.00	50.00	6.00			
V	52.00	48.00	25.00	50.00	50.00	11.20	49.78	50.22	22.30
VI	50.32	49.68	31.80	50.49	49.51	20.80	50.00	50.00	28.00
VII	50.45	49.55	39.45	51.16	48.84	28.15	50.00	50.00	34.00

Table 24₃₁. Measurements of regenerating and normal legs, 31.

No. 68 Instar	Fore leg				Mid - leg				Hid - leg			
	F		T		F		T		F		T	
	t. l. p.	t. l. p.	length	Total length	t. l. p.	t. l. p.	length	Total length	t. l. p.	t. l. p.	length	Total length
II	52.63	47.37	9.50		50.00	50.00	8.00		47.37	52.63	9.50	
III	51.50	48.50	13.40		49.13	50.80	11.40		46.16	53.84	13.00	46.64
IV	47.06	52.94	18.70		50.00	50.00	15.00		47.23	52.77	18.00	53.85
V	50.00	50.00	26.00		50.00	50.00	20.00		48.06	51.94	23.10	46.85

Table 24₃₂. Measurements of regenerating and normal legs, 32.

No. 86 Instar	Fore leg				Mid - leg				Hind leg			
	F		T		F		T		F		T	
	t. l. p.	t. l. p.	length	Total length	t. l. p.	t. l. p.	length	Total length	t. l. p.	t. l. p.	length	Total length
IV	68.37	31.63	15.80	51.43	48.57	21.00	50.45	49.55	16.65	47.92	52.08	19.20
V	63.05	36.95	23.00	49.66	50.34	28.80	49.78	50.22	22.10	50.00	50.00	26.00
VI	55.27	44.73	38.00	47.73	52.27	44.00	50.77	49.23	32.50	48.77	51.23	40.60

Table 24₃₃. Measurements of regenerating and normal legs, 33.

No. 87 Instar	Fore leg			Mid - leg			Hind leg		
	F t.l.p.	T t.l.p.	Total length	F t.l.p.	T t.l.p.	Total length	F t.l.p.	T t.l.p.	Total length
IV	50.00	50.00	19.80	66.67	33.33	10.80	50.00	50.00	14.20
V	52.00	48.00	25.00	65.39	34.61	13.00	66.67	33.33	13.50
VI	50.45	49.55	33.70	63.93	36.07	20.20	54.17	45.83	24.00
VII	49.07	50.93	42.80	60.12	39.88	25.60	51.03	48.97	29.40
							47.30	52.70	37.00

Table 24₃₄. Measurements of regenerating and normal legs, 34.

No. 75 Instar	Fore leg			Mid - leg			Hind leg		
	F t.l.p.	T t.l.p.	Total length	F t.l.p.	T t.l.p.	Total length	F t.l.p.	T t.l.p.	Total length
II	51.49	48.51	10.10	48.79	51.21	8.20	57.98	42.02	6.90
III	51.73	48.27	14.50	50.42	49.58	11.90	64.71	35.29	8.50
IV	51.27	48.73	19.70	46.98	53.03	14.90	62.50	37.50	11.20
V	51.21	47.79	27.20	50.23	49.77	21.90	55.56	44.44	16.20
							50.00	50.00	24.00

Table 24₃. Measurements of regenerating and normal legs, 35.

No. 63	Fore leg					Mid - leg					Hind leg				
	F			T		F			T		F			T	
	t.l.p.	t.l.p.	length	t.l.p.	length	t.l.p.	t.l.p.	length	t.l.p.	length	t.l.p.	t.l.p.	length	t.l.p.	length
Instar															
II	54.55	45.45	11.00	48.36	51.64	9.10	48.00	52.00	10.00		50.00	50.00	50.00	50.00	1.00
III	52.39	47.61	14.70	50.00	50.00	12.00	47.78	52.22	18.00	48.79	51.21	4.10			
IV	51.26	48.74	19.90	51.62	48.38	15.50	48.67	51.33	22.40	51.36	48.64	14.80			
V	52.39	47.64	24.15	48.71	51.29	19.30	48.59	51.41	28.00	48.95	51.05	23.70			
VI	52.31	47.69	30.40	51.44	48.56	22.65									

Table 24₃. Measurements of regenerating and normal legs, 36.

No. 79	Fore leg					Mid - leg					Hind leg				
	F			T		F			T		F			T	
	t.l.p.	t.l.p.	length	t.l.p.	length	t.l.p.	t.l.p.	length	t.l.p.	length	t.l.p.	t.l.p.	length	t.l.p.	length
Instar															
IV	50.99	49.01	20.40	97.53	2.47	10.15	50.00	50.00	16.00	48.92	51.08	18.40			
V	50.99	49.01	26.50	92.59	7.41	13.50	49.61	50.49	20.20	50.05	49.95	22.70			
VI	52.18	47.82	34.50	82.47	17.53	19.40	50.00	50.00	26.00	50.00	50.00	30.00			
VII	50.00	50.00	42.00	71.69	28.31	26.50	49.85	50.15	31.40	49.02	50.98	35.70			

Table 24₃₇. Measurements of regenerating and normal legs, 37.

No. 80 Instar	Fore leg				Mid - leg				Hind leg			
	F t.l.p.	T t.l.p.	Total length		F t.l.p.	T t.l.p.	Total length		F t.l.p.	T t.l.p.	Total length	
III	51.90	48.10	15.80		50.79	49.21	12.80		48.65	51.35	14.80	
IV	50.23	49.77	21.90		47.68	52.32	17.20		48.25	51.75	19.90	5.00
V	50.00	50.00	31.20		52.17	47.83	23.00		49.46	50.54	27.30	17.50
VI	46.53	53.47	44.90		48.49	51.51	33.00		47.62	52.38	39.00	35.00

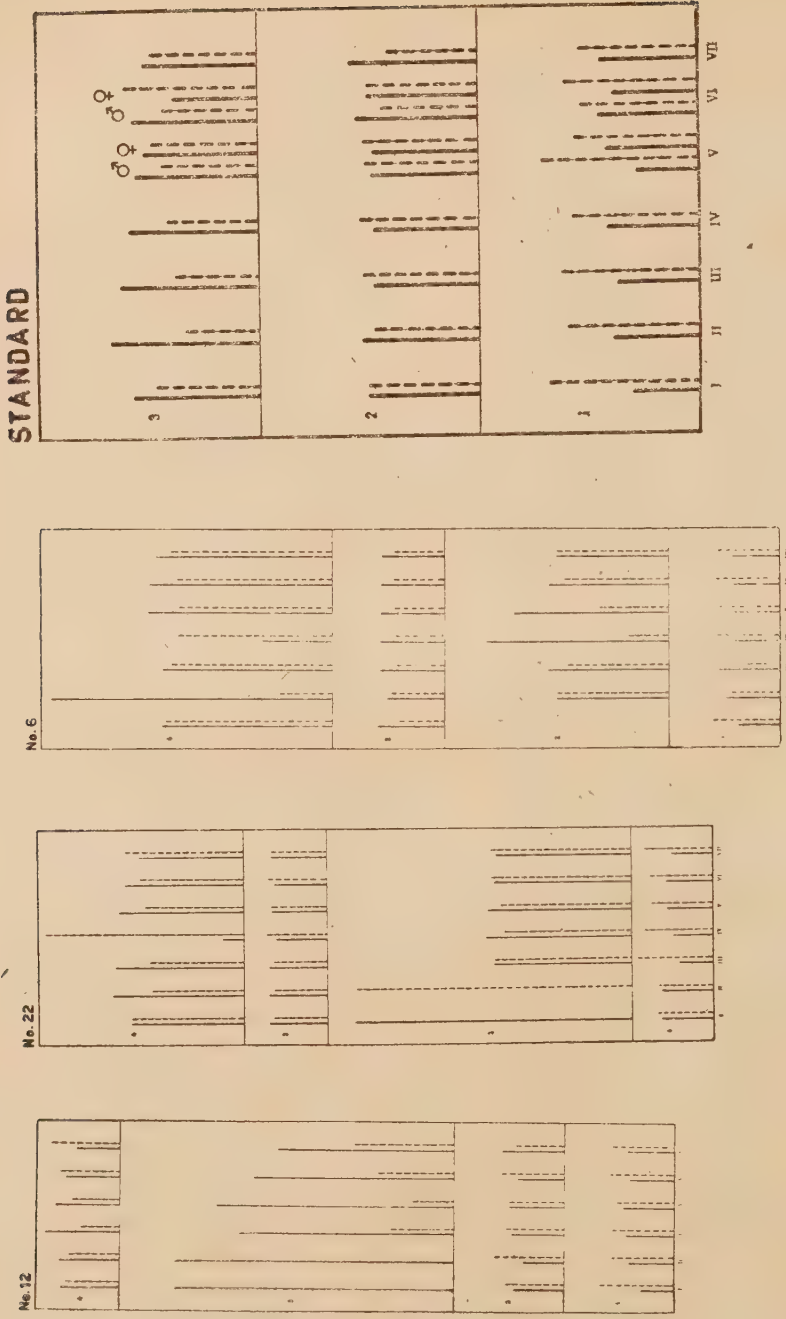
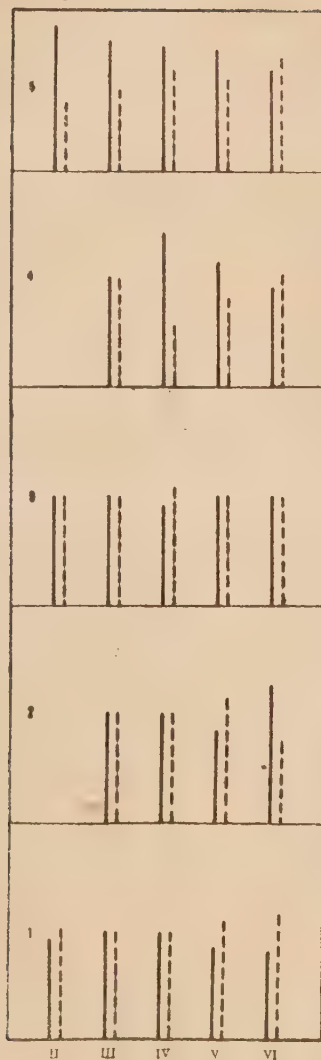
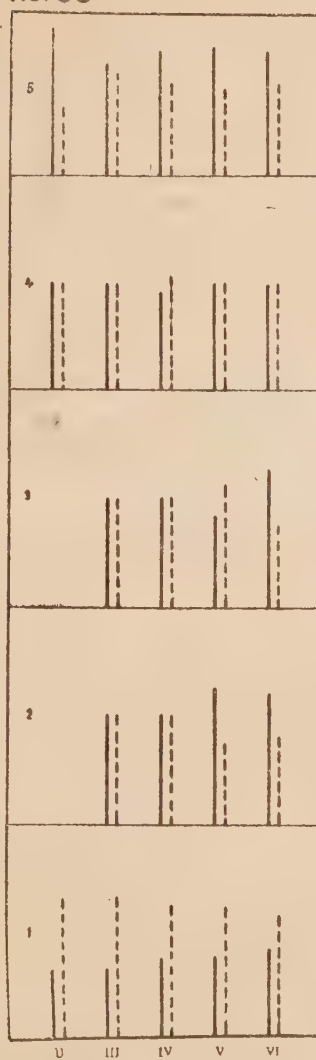


Fig. 24. Graph showing the relative proportions of the different segments of the leg. Ratio of the length of the segments to the total length of the leg expressed in percentages. Full lines represent the femur. Broken lines indicate the tibia. (In the case of the standard—1: Fore leg, 2: Mid-leg, 3: Hind leg.).

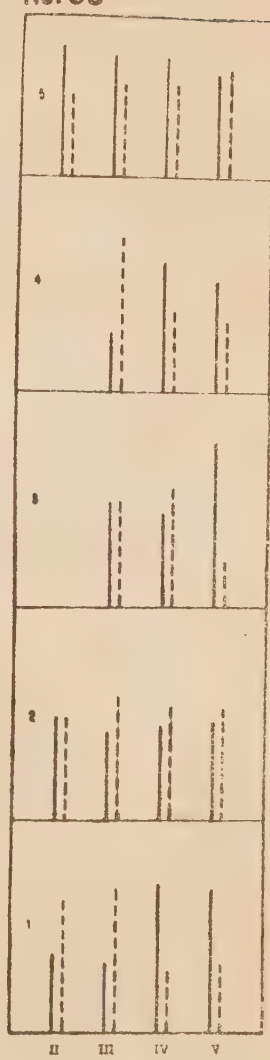
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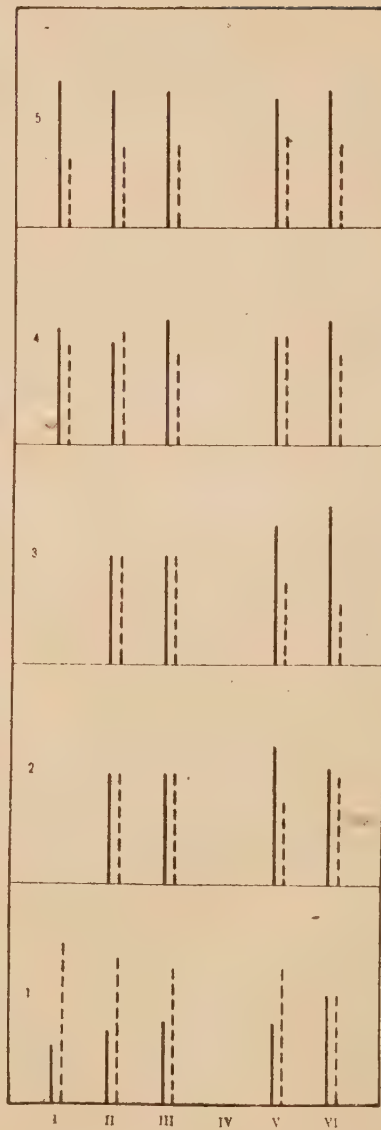
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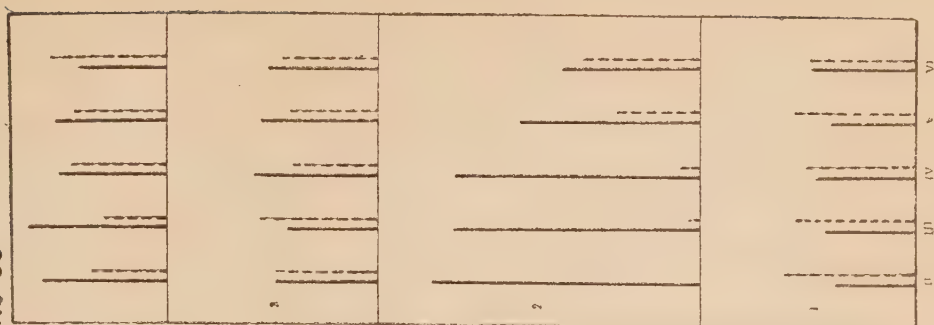
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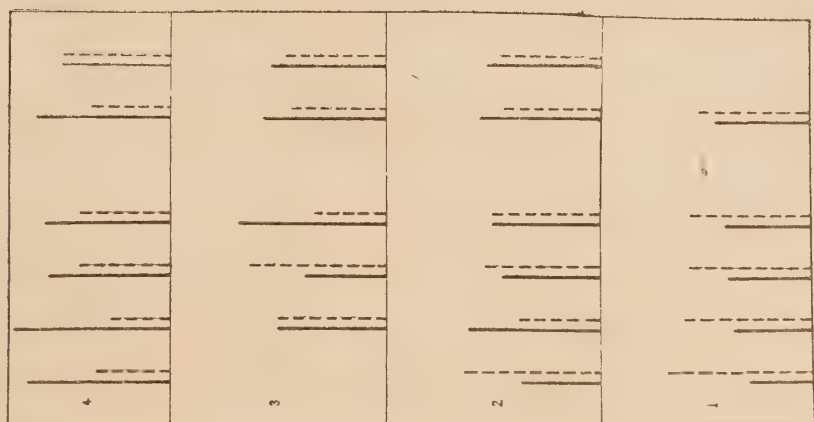
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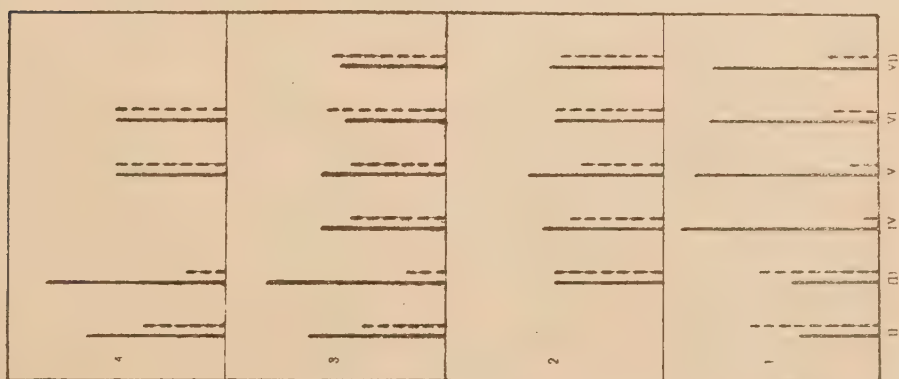
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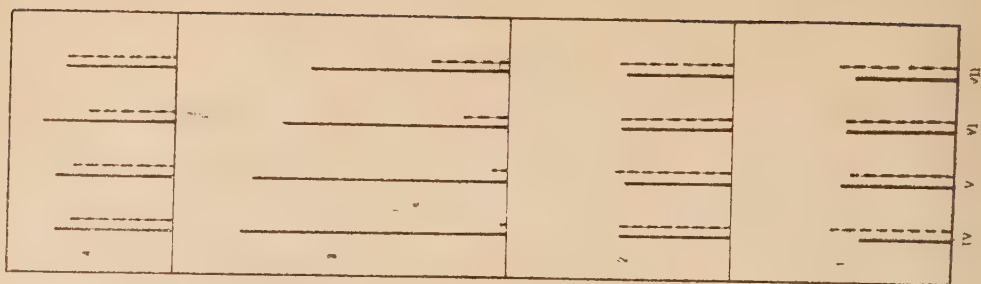
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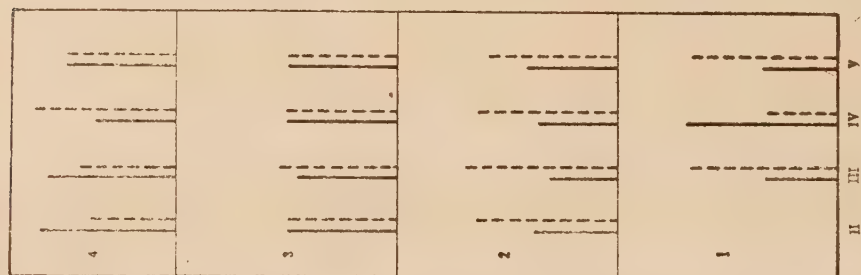
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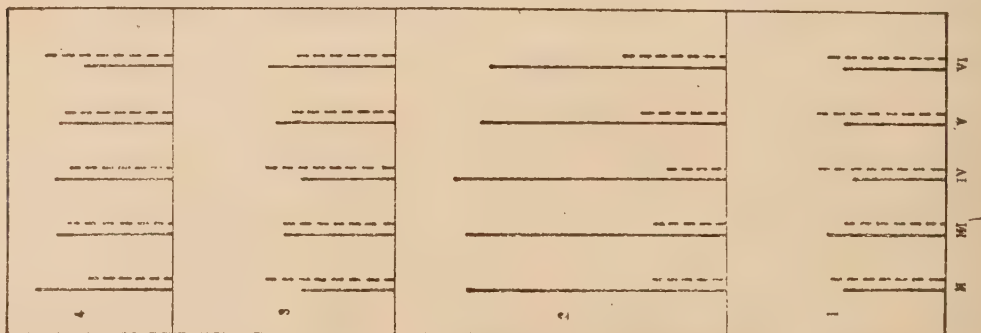
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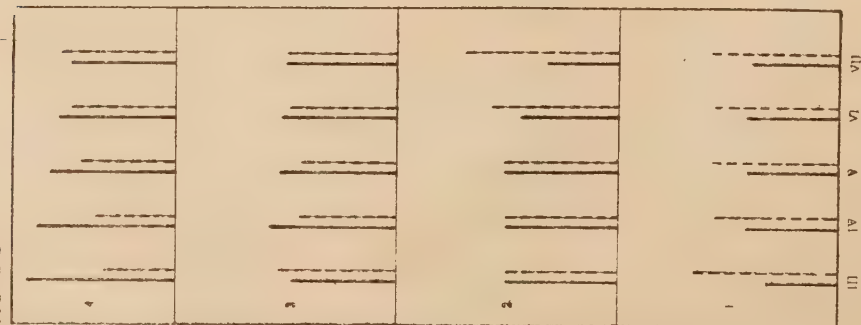
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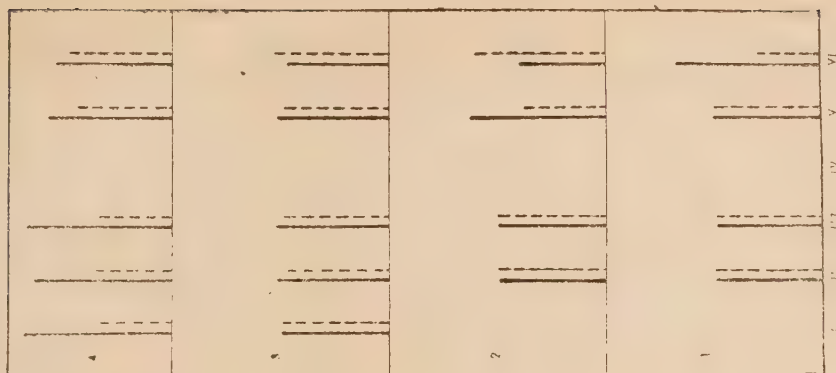
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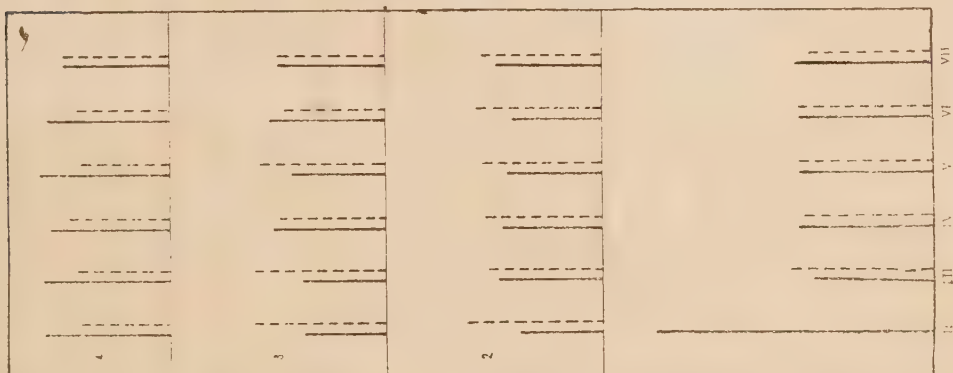
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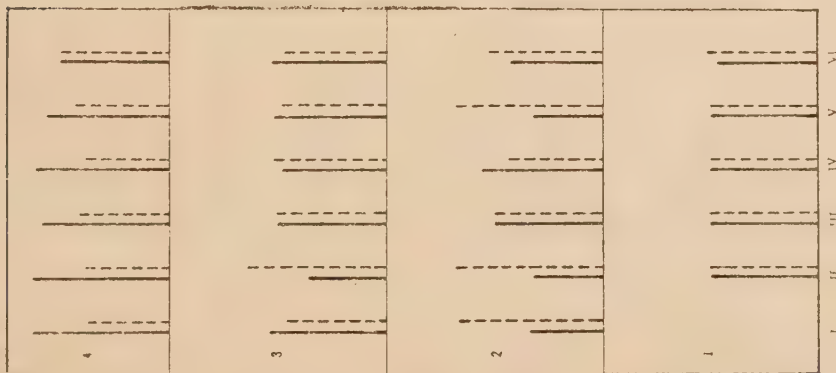
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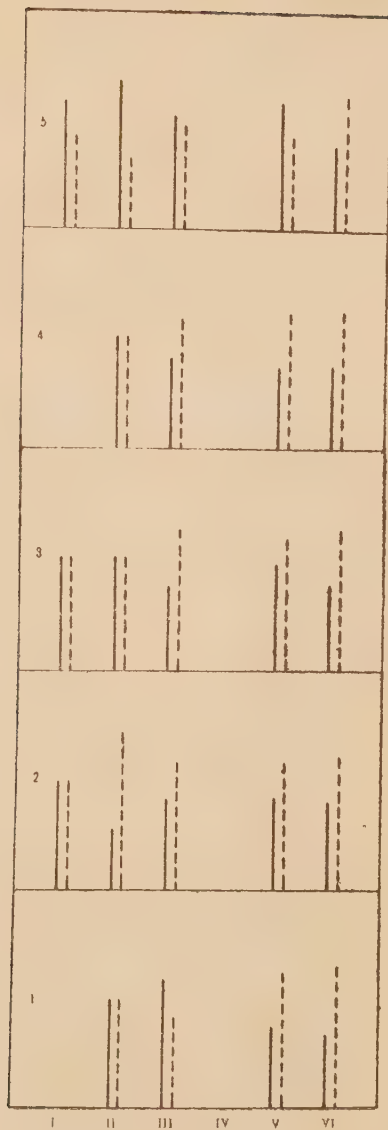
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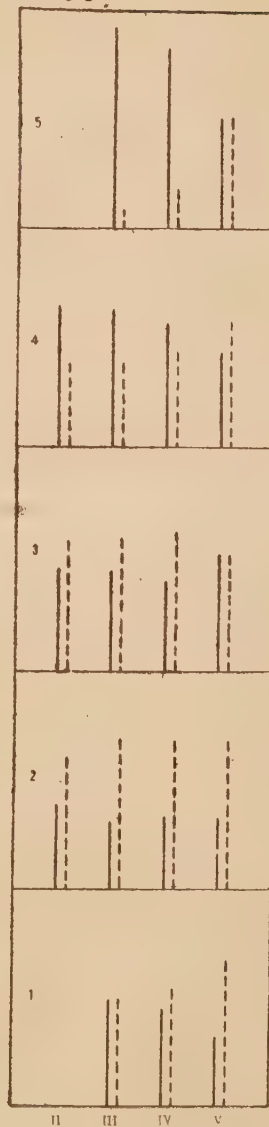
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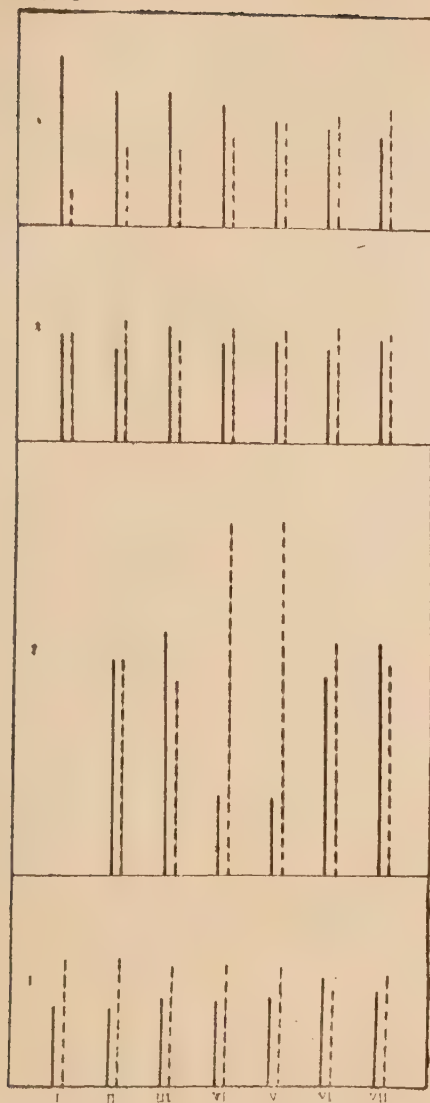
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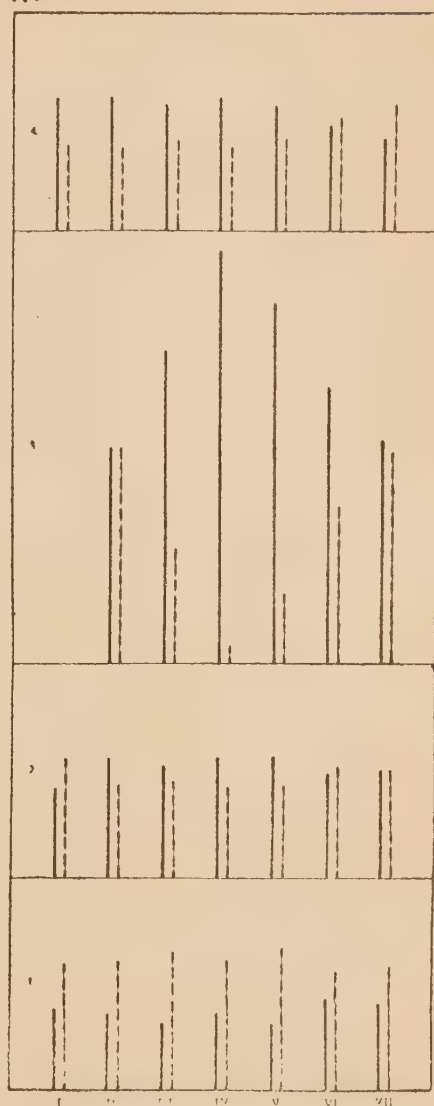
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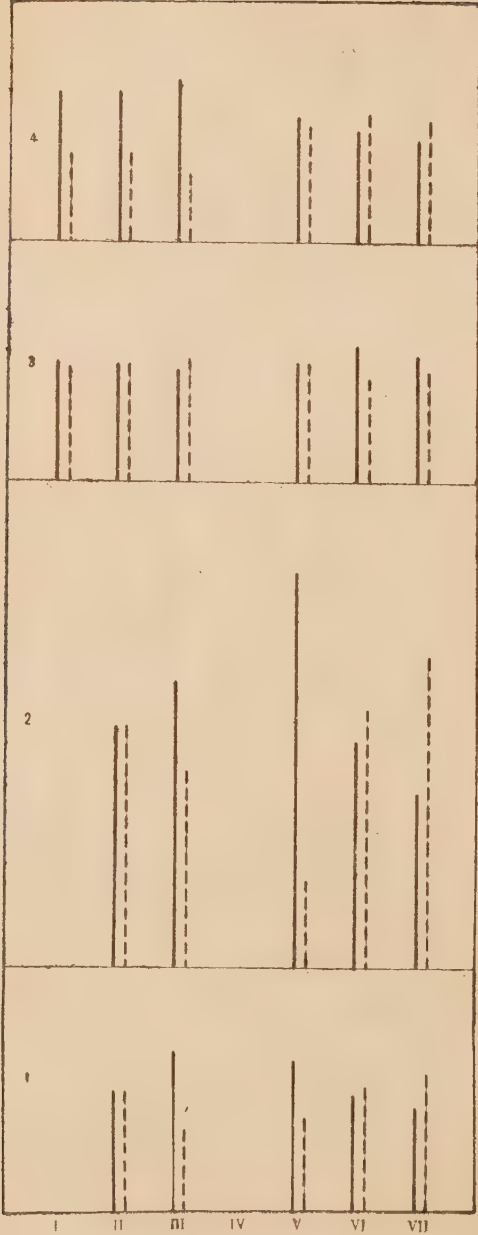
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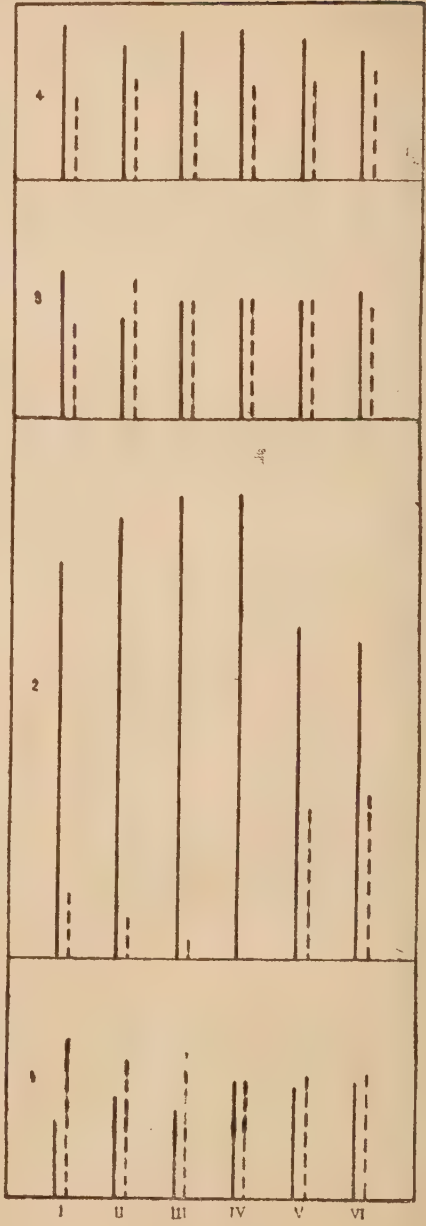
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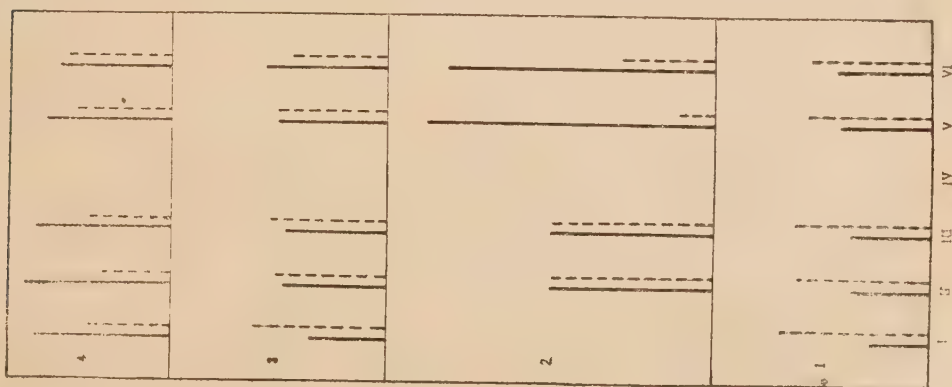
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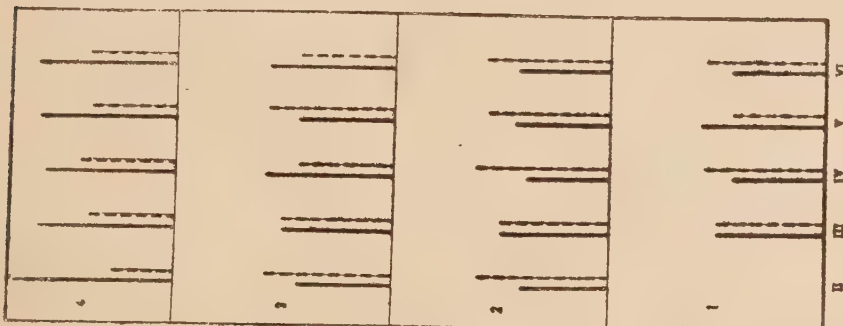
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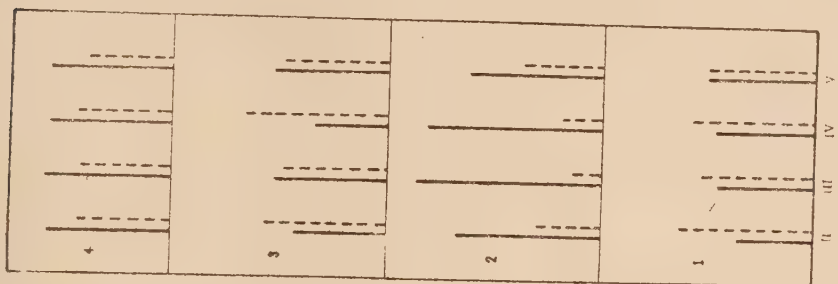
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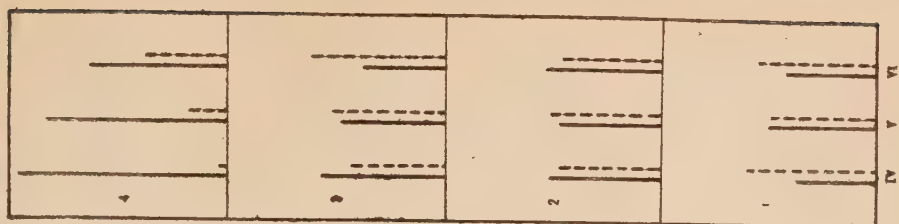
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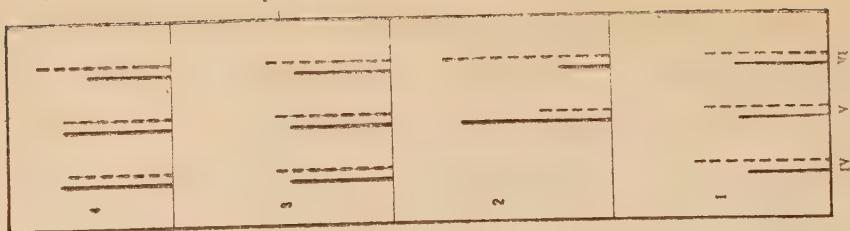
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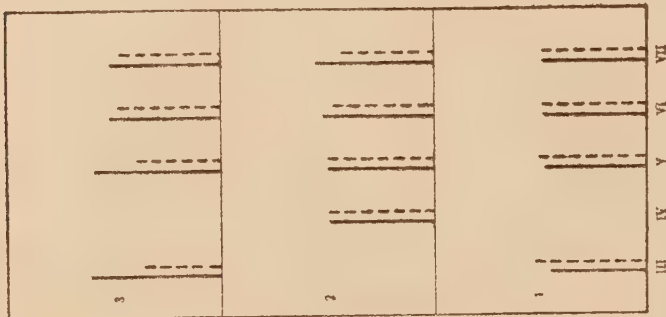
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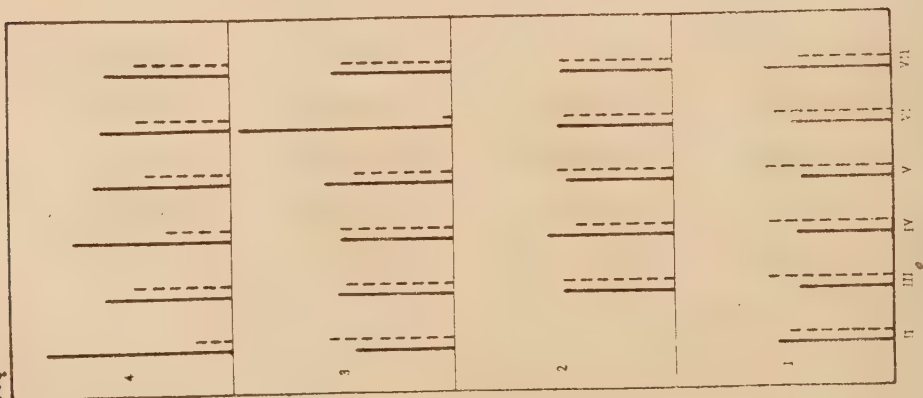
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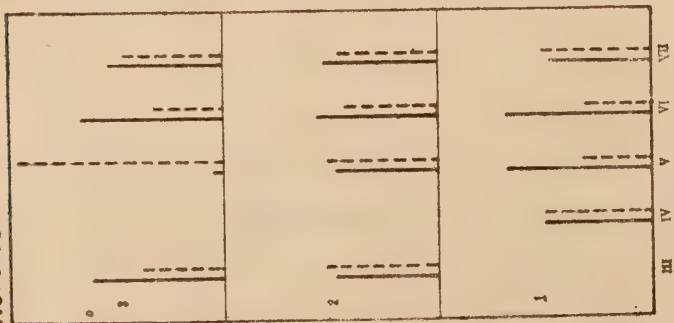
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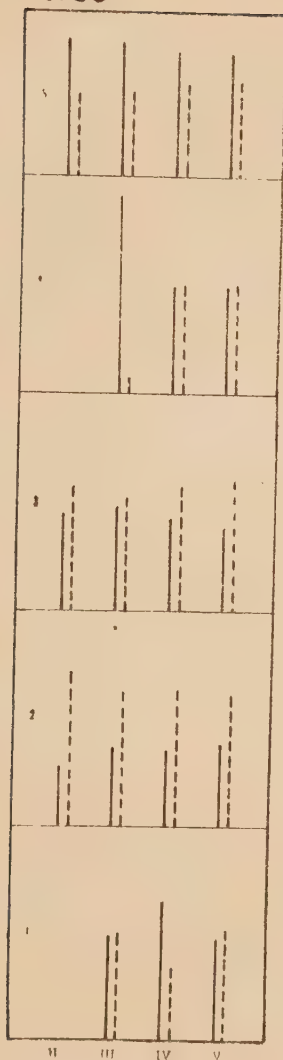
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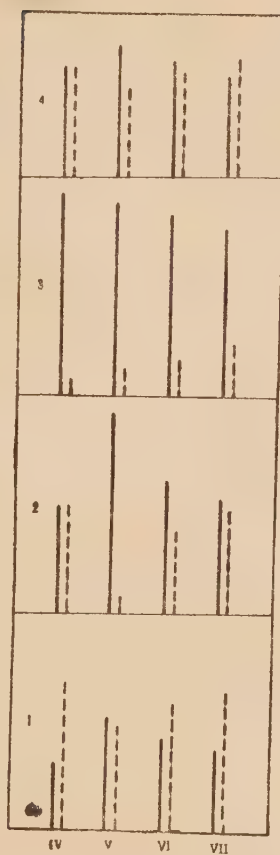
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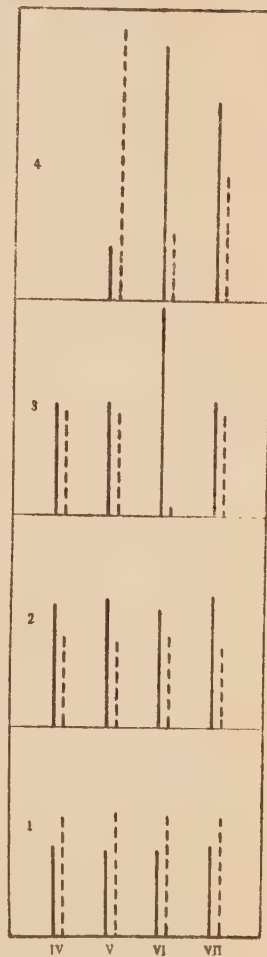
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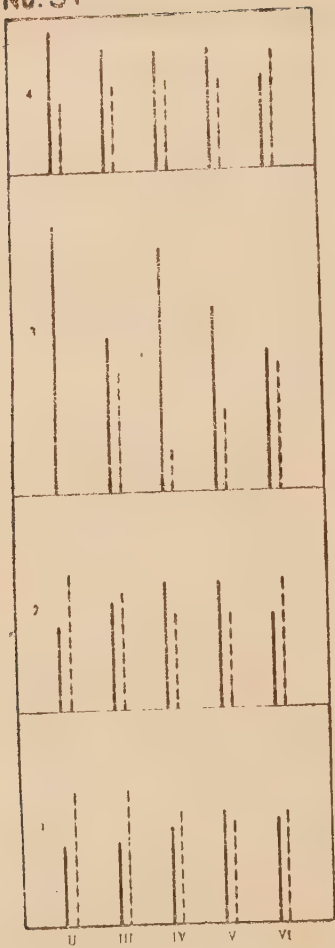
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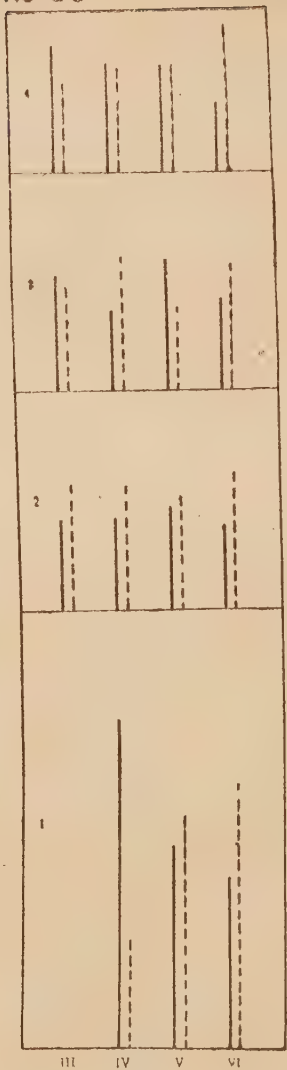
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2. Discussions

The effect of the regenerating legs upon the normally developing legs in the post-embryonic stages of some Arthropoda has been studied by several authors, including HÜBNER (1902, *Chloëon dipterum*), MEGUSAR (1907, *Hydrophilus caraboides*, *Tenebrio molitor*), PRZIBRAM (1917, *Sphodromantis bioculata*), GABRITCHEWSKY (1926-, Spiders), HUXLEY (1927, *Maia squinado*), SHAW (1928, *Inachus dorsettensis*), TAZELAAR (1938, *Chloëon dipterum*), DIXEY (1938, *Gammarus chevreuxii*) and PAULIAN (1938, *Palaemon squilla*, *Eupagurus prideauxii*, *Chloëon dipterum*, *Chloëon simile*). The study made by DUARTE (1938) on the African locust, *Locusta migratoria migratorioides*, is also of interest in the problem of the same line.

HÜBNER amputated the right-hand tracheal gill of the abdomen of *Chloëon dipterum* and observed the atrophy of the left-hand tracheal gill in successive instars. The experiment carried out by MEGUSAR on the larva of *Hydrophilus caraboides* showed a similar result (compensatory reduction) as that of HÜBNER. He amputated one mandible of the larva and found that the other mandible of the opposite side became smaller than in the preceding stadium in the next stage and more simplified in the successive stadia. He also amputated the hind leg of a full-grown larva of *Tenebrio molitor* and observed that the elytron of the same side as the operated hind leg of the newly emerged adult showed a considerable deformation. But this striking result may be merely of mechanical nature and seems to have been derived from the effect of the insufficient humidity of the rearing medium. PRZIBRAM made a series of experiments on *Sphodromantis bioculata* and found the positive effect produced by regenerating legs upon neighbouring appendages. His studies may be summarized as follows. After the amputation of a fore or mid-leg the growth-rate of the leg just posterior to it was first depressed during the period, in which the regeneration was most active, then was accelerated to a degree more than normal, and finally dropped to or below normal. After the amputation of a hind leg a similar effect was produced in the anterior legs, but the initial depression was greater and the later increase more slight than in the preceding case. GABRITCHEWSKY carried out a series of experiments on spiders and showed that

the regeneration of one leg caused some modifications (atrophy and hypertrophy in the chaetotaxy, claws and coloration) in neighbouring appendages. He called such an effect under the name "induction spécifique à distance". HUXLEY (in *Maia squinado*), SHAW (in *Inachus dorsettensis*) and TAZELAAR (in *Palaemon carcinus*) demonstrated the fact that there was a slight increase in size in the appendages just posterior to the regenerating (allometric) appendage, but there was also a slight decrease in size in those immediately anterior to it. In his further experiments on the mayfly larvae, TAZELAAR removed repeatedly the mid-leg of one side of young larvae of *Chloëon dipterum* and investigated the effect on the legs anterior and posterior to it. In the normal legs the relative length of tarsus decreased with increasing absolute size, while in the regenerating leg this percentage was initially smaller than in the controls, but increased with increasing absolute size until the control value was reached. The relative tibia-length and femur-length in the normal legs increased slightly with increase in size. In the regenerating legs the relative tibia-length was at first larger than normal and then decreased irregularly with increase in size; the relative femur-length remained about equal to that of the controls. His result implied that the mechanisms of regenerative and normal growth were independent and not identical with each other and rapid growth in regeneration did not affect the normal growth of neighbouring legs. DIXEY also made repeated amputations on the appendages of young *Gammarus chevreuxi* in order to determine the effects on the growth-rates of legs anterior and posterior to them and demonstrated that any effects produced in this way were of a temporary nature which could not be detected by his methods used. PAULIAN made some experimental studies on four species of Arthropoda. In *Palaemon squilla*, *Eupagurus prideauxii* and *Chloëon simile*, no sensible results were detected. In *Chloëon dipterum* the results were more or less complicated. DUARTE supposed that the gregarious phase of the African locust was a result of the jumping activity of the young locusts and studied the effect of the amputation of hind tibiae on crowded locusts. The locusts with their hind tibiae cut off did not develop well as those of the control, and the hind femur, as a consequence of its useless condition, became extremely short as compared with the elytra. Further the

occurrence of the black-orange coloration was stronger and more uniform in the normal locusts than in the operated ones.

In my opinion such problem as to detect the presence or absence of the effects of the regenerating legs upon the normally growing legs can be analysed safely only by the careful measurements of many individuals separately, as the considerations based upon the mean value of the measurements would often eliminate the fact hidden within the problem. It is evident from my results mentioned above, that the effects of the regenerating legs upon neighbouring appendages are either positive or negative. But it must not be forgotten that the normal legs as a whole never showed any atrophic nor hypertrophic growth, and the effects which I imply, if present, are only seen in the variation of the proportion of the components of the legs themselves. Further it must be borne in mind that the regeneration curves of many examples are of the same and a single type as investigated in the preceding chapter. It is true that the allometric organ influences the growth-gradients of neighbouring organs as well as parts of the body. This shows that a localized region of rapid growth cannot be regarded as completely isolated, but undoubtedly operates within the main growth gradient of the body. Amputation may be regarded as to make an artificially induced centre of high growth intensity, and a regenerating leg presumably forms a centre of very active growth. My results demonstrate partly that the regenerating legs give a similar effect on neighbouring appendages as normal allometric organ, and partly that they do not affect the normal growth of neighbouring legs as contrasted with the former case. In these points my experimental results do not coincide with those of TAZELAAR, etc. But there is, of course a distinct difference between normally growing and regenerating legs in their actual mechanisms of growth in nature, and the regeneration itself is not a simple phenomenon as to be expressed by PRZIBRAM (1919) under the name of accelerated growth. The regenerating leg seems to develop quite independently of the normal growth of neighbouring legs. Thus it may be supposed that certain specific growth-promoting and growth-inhibiting factors may play role within the regenerating legs in producing its characteristic growth.

G. The "Raison d'être" of DYAR's Rule, PRZIBRAM's Principle and TOKUNAGA's Formula

Consulting the literature and experiments as discussed above, I have to express some opinion concerning the growth of insects. The well known ideas illustrating the growth of insects are DYAR's rule, PRZIBRAM's principle and TOKUNAGA's formula, a modification of ROBERTSON's formula of monomolecular autocatalytic chemical reaction. Generally speaking, high growth-ratios are encountered in the early part of larval development, and there is a tendency of diminishing of the growth-ratios during the larval development. It is quite artificial to consider the first larval stage separately from the later stages, only because of the fact that the size of the first larval stage has already been decided in the embryonic development, while the growth of the later stages depends mainly upon nutrition. There exists also a reason to assume, that the size of the first larval stage is the standard or basis of all sizes of the later stages, including the determinate specific size of the adult insects, which are originated in the size of the first larval stage. Growth in insects is not a phenomenon of a closed system but an open one, taking nutriment from the environment and continuing excretion during the course of larval development and is a combined result of much more complicated biological phenomena. Notwithstanding it must be pointed out that the growth in insects is not performed at random but by a regular manner specific to each insect or to each organ. To explain the growth process in insects as a monomolecular autocatalytic chemical reaction means to treat insects as not living and homogeneous chemical substances. Apparently this idea may be considered as a fault. Therefore, the coincidence of the growth curve with that of the monomolecular autocatalytic chemical reaction must be taken as merely accidental and the growth rate must be analysed by some other method. In the least the growth of the appendages of my experiments must be analysed by the idea of the growth-promoting and growth-inhibiting factors. The general growth curve must be considered empirically, and the equation illustrating the curve, if needed, must be constructed by the aid of analytical geometry. The equations given by GAINS and CAMPBELL (1935) and WOODRUFF (1939), using three parameters

or constants, will be held good for the indication of the linear growth in insects. On the other hand, regeneration may be regarded as an exaggeration of normal growth in insects. The locus of equilibrium between the growth-promoting and growth-inhibiting factors takes several different routes in the growth process of regenerate appendages. Really, we cannot recognize both DYAR's rule and PRZIBRAM's principle for the growth of insect in general. Further BODENHEIMER's latent division steps theory is quite speculative, assuming often false cell divisions in the larval development. As a matter of fact both DYAR's and PRZIBRAM's laws may be regarded as representing a special case of insect growth following a regular geometrical progression. In case that the growth-ratio is 1.26, it is fairly safe to say that PRZIBRAM's principle is fully applicable to the growth of the insect in question.

H. Summary

1. The growth of larvae of *Phraortes kumamotoensis* was investigated with regard to the length.
2. The percentage increase in length (or width) in each instar was calculated by the formula

$$\alpha = \frac{L_{n+1} - L_n}{L_n} \times 100,$$

where L_n designates the length of part measured in the instar n . The results are seen in full detail in the Chapter IV, A.

3. The percentage length of the allometric organs in each instar was calculated by the formula,

$$\beta = \frac{\text{Length of the part in the instar } n}{\text{Ultimate length of the part}} \times 100.$$

In the cases of appendages β takes a value 50% in the fourth instar. In the allometric organs other than the appendages of the female β secures also a value 50% in the fourth instar, while in the male β attained a value 50% early in the third instar.

4. The change of the partial indices of the allometric organs during the post-embryonic developmental period was studied. The partial index (γ) of any allometric organ was calculated by the formula,

$$\gamma = \frac{\text{Length of the allometric organ}}{\text{Total length of the body}} \times 100.$$

The results are seen in full detail in the Chapter IV, A.

5. The relative growth of the allometric organs was investigated by using the allometric formula $y = bx^a$. The detailed account may be seen in the Chapter IV, B.
6. The growth of the regenerate allometric organs was investigated. Nineteen classes of regeneration experiments were performed using hundreds of individuals.
7. In the regenerate appendages there is seen a definite tendency of diminishing of the growth-ratios during development. The growth-ratios between the first regenerates and the regenerates after the subsequent moult show a marked tendency to exceed the value required by PRZIBRAM's theory and even a value of 2.
8. The percentage length (β') of any allometric organs in each instar was calculated by the formula,

$$\beta' = \frac{\text{Length of the regenerate in the instar } n}{\text{Ultimate length of the regenerate}} \times 100.$$

The β' takes the value fairly equal to that of β in the preadult instar, and β' value previous to the preadult instar is much smaller than that of β . In general β' never exceed the value 10 in the instar when the regenerate first appeared or even in the succeeding instars.

9. Convergence in length between regenerating and normal legs was investigated. The convergency quotient was calculated by the formula,

$$\delta = \frac{(\text{Length of normal appendage}) - (\text{Length of a regenerate})}{\text{Length of normal appendage}} \times 100.$$

10. The convergency quotient in the length of appendages is not constant in succeeding instars and may be divided into three phases which do not vary in a regular order. The first two instars may be regarded as representing the first phase where the change of the quotient is smaller than that of the second phase. The second phase consists of the two following instars and its quotient is slightly greater than that of the third phase, which is represented by the two last instars.

11. The absolute length of the radius of curvature of the first phase-curve seems to be slightly larger than that of the third phase-curve, and further the features of the former and the latter are entirely reverse to each other. Similarly the radii of curvature of the anterior and posterior halves of the second phase-curve are also reverse to each other.
12. During the process of regeneration the growth-ratios of any of the regenerates are much higher or lower than the normal and gradually approach the normal value, though the growth-ratios change their values at every instar irregularly.
13. The frequency distribution of the growth-ratios of the regenerates (femora and tibiae) in the second regeneration phase was investigated. The mode of distribution occurs between 6 and 7, and the majority of the growth-ratios are located between 0.0 and 11.7. There are found the exceptional growth-ratios such as 13.69, 14.00, 15.41, 17.11, 17.28, 18.57, 42.00 and 42.66.
14. The mode of distribution in the third regeneration phase occurs between 4 and 5, and the majority of the growth-ratios are situated between 0.2 and 9.1.
15. The mode of distribution in the fourth regeneration phase lies between 2 and 3, and the majority of the growth-ratios are located between 0.6 and 9.5.
16. The mode of distribution in the fifth regeneration phase occurs below 2.0, and the majority of the growth-ratios are located between 0.8 and 5.4.
17. The mode of distribution in the last regeneration phase lies about 1.5, and the majority of the growth-ratios are seen between 0.5 and 2.3.
18. Thus the growth-ratios show a marked tendency to reduce the value towards the last regeneration phase, and the width of the frequency distribution of the growth-ratios becomes narrower phase after phase.
19. PRZIBRAM's statement that the regeneration is an accelerated growth seems to be insufficient to explain the whole phenomenon of regeneration and needs revision to a certain extent. The regeneration curves may be classified into several groups. In spite of some irregularities, the following four trends of regeneration curves are to be noted during

the course of normal regeneration (regeneration caused by autotomy).

- A. Decreasing type (PRZIBRAM, 1917). The decreasing rate with age is perfectly evident.
 - B. Intermediate type (new type). The decreasing rate with age is recognizable in the earlier period, and the increasing rate is pronounced in the later period, or vice versa.
 - C. Uniform type (new type). The rate of regeneration may be expressed by a straight line throughout the instars.
 - D. Increasing type (new type). The increasing rate with age is noted.
20. The decreasing type is the commonest among the four ones taking 72.87%, and the intermediate type occurs less frequently, taking 16.42%. Both the uniform and increasing types are rarely observed, taking 7.32 and 3.39% respectively.
 21. The slope of the regeneration curve of the basitarsus is always steeper than that of the remaining parts of the tarsus.
 22. There exists a distinct and high correlation between the femur and tibia in a regenerate leg throughout a period of the post-embryonic growth. The combination of the same type of regeneration curve is predominant in the regenerate process. The decreasing-decreasing type encountered was 69.73%, the intermediate-intermediate type being 15.78%, the uniform-uniform type being 3.94% and the increasing-increasing type being 2.63%.
 23. The regeneration curve of the regenerate femur which is amputated at any point except for the trochantero-femoral part takes a J-shaped curve (new type), the highly decreasing rate with age is evident in the earlier period or the curve runs down below the X-axis, and then the curve takes the type same as the decreasing one of the normal regeneration.
 24. The regeneration curve of a newly produced tibia or tarsus takes one of the following types: decreasing type, intermediate type, uniform type, increasing type, or J-type.
 25. The regeneration curve of a tibia which has lost its apical part by amputation takes one of the following types: normal growth type, intermediate type, or increasing type.
 26. The regeneration curve of a tarsus which has lost its entire distal parts except for the base of the basitarsus by operation

takes either of the following types: decreasing type, increasing type.

27. The regeneration curve of an antenna which has lost its flagellum except its base by amputation takes one of the following types: J-type, decreasing type, intermediate type, uniform type, or increasing type.
28. The equation for the regeneration curve offered by PAULIAN seems to be insufficient to illustrate all the curves of regeneration.
29. In the epidermis of the appendages two factors, growth-promoting and growth-inhibiting, seems to reside and have no direct relationship with the amount of material in the body.
30. The distribution of two factors along the longitudinal axis within each segment of an appendage seems to be quite definite, *i.e.* the growth-promoting factor being much the densest at extreme apex while the growth-inhibiting one being homogeneously dense.
31. These two factors seem to stimulate each other. In normally developing appendages an equilibrium between two factors appears to be retained in each instar in each segments of the appendages.
32. Complete removal of a femur implies complete exposure of growth-promoting factor at the trochantero-femoral suture, and such an operation results a highly positive action of the growth-promoting factor.
33. The partial removal of an appendage implies exposure of a part where relative density of the growth-promoting factor is low and the same of the growth-inhibiting factor is very high. As the result of the partial removal of the appendage, enantiotometry occurs after the time of operation.
34. With the aid of such an idea of the growth-promoting and growth-inhibiting factors we may be able to explain the phenomenon of overgrowth of a regenerate.
35. As to the growth factors, basal two segments of the antenna are homologous to the segments of the legs, but the antennal flagellum is somewhat different from such parts as mentioned above both in nature and the distribution of the factors.
36. As to the segmentation of the regenerate tarsus the following exceptional cases were observed: one-segmented tarsus, two-

- segmented tarsus, three-segmented tarsus, five-segmented tarsus.
37. In the regenerate antennae the substitutional homoeosis is common.
 38. I have observed two examples, in which addition of new formation to a regenerate appendage occurred.
 39. The proximo-distal symmetry of a regenerate may be produced not only by the transplantation (of scape and pedicel in *Anisolabis maritima*) but also by the normal regeneration by means of the action of some stimuli. The regenerate tibia can produce not only the more distal but also the more proximal segments.
 40. Some examples of duplication and triplication of the regenerate were observed.
 41. A single case of segregation of the tarsus from the tibia was observed.
 42. Some examples of shortening of the regenerate tibia were observed.
 43. Some examples of the formation of an unknown segment, possibly a patella, between the regenerate femur and tibia were observed. This phenomenon seems to demonstrate the lower grade of differentiation of the tibial segment in the present insect.
 44. The effect of the regenerating legs upon the normally developing legs was investigated.
 45. Change of a proportional length of the segments in regenerating legs was studied. In regenerating fore legs three different types were observed. In regenerating mid-legs four types were observed. In regenerating hind legs six types were observed.
 46. Influence of a regenerating leg upon normally developing legs was investigated. Influence of the regenerating fore leg was classified into eight cases. Influence of the regenerating mid-leg was divided also into eight cases. Influence of the regenerating hind leg was divided into nine cases.
 47. Influence of two or three regenerating legs upon normally developing legs was studied, and ten different cases were observed.
 48. The effects of the regenerating legs upon neighbouring appendages are either positive or negative. The normal legs as a whole never showed any atrophic nor hypertrophic

growth, and the effects, if present, were only seen in the variation of the proportion of the components of the legs themselves.

49. There is a distinct difference in nature between normally growing and regenerating legs in their actual mechanisms of growth, and the regeneration itself is not a simple phenomenon as expressed by PRZIBRAM under the name "accelerated growth."
50. The regenerate seems to develop quite independently of the growth of normal neighbouring legs.
51. There seems to exist no fundamental basis to eliminate the first larval stage from the later stadia in the analysis of the growth in insects.
52. The coincidence of the growth curves with the curve of monomolecular autocatalytic chemical reaction is merely accidental. We can not recognize both DYAR's rule and PRZIBRAM's principle as illustrating the growth of insects in general. As a matter of fact both DYAR's and PRZIBRAM's laws can be regarded only as representing the special cases of insect growth, following a regular geometrical progression.

V. GROWTH IN WEIGHT

A. Historical

In his studies on Crustacea, BROOKS (1886) found that there is a definite increase in length at each successive moult of this group of Arthropoda. In the development of the larva of *Coronis* he found that the length of the larva increases uniformly at each moult by one-fourth of its length before the moult.

DYAR (1890) observed that in Lepidoptera, the width of the head of the larva in its successive stages follows a regular geometrical progression. This fact then became known as DYAR's rule or DYAR's law.

PRZIBRAM and MEGUSAR (1912), in their studies on the Egyptian praying mantis, *Sphodromantis bioculata*, found that the weight of the shed skin and of the newly moulted insect show a doubling from moult to moult, while increases in linear dimensions between two successive moults occurred as the cube root of 2 or 1.26 and in area as the square root of 2 or 1.41. Each instar having a

doubling of weight and a linear increase of 1.26 was called by the authors a true "division step" or "Teilungsschritt." These biological stages were assumed to follow after the fashion of a geometrical progression whose exponent is 2, corresponding to the division of cells. This was called as PRZIBRAM's principle. Such authors as PRZIBRAM (1913, 1930), SZTERN (1914), TITSCHACK (1924), EIDMANN (1924), TEISSIER (1926, 1928), BODENHEIMER (1927, 1932, 1933), FRIZA (1928), PRZIBRAM and BRECHER (1930), YAMANOUTI (1926), etc., have attempted to demonstrate the application of PRZIBRAM's principle to insects with incomplete metamorphosis. In this principle, the definite progression in the growth of the insect is supposed to be resulted from a single division of the body cells. The progression implies that each moult represents a definite increase in size which is correlated with a definite number of cell divisions. It also postulates that between two moults all cells have divided only once. SZTERN (1914) advanced the hypothesis that there is a simultaneous division of all cells in *Sphodromantis bioculata* in each stage, and BODENHEIMER (1933) again stated that a simultaneous division of all body-cells may occur in insects.

HUETTNER (1923) reported that in *Drosophila melanogaster* all cells are in the same stage of division during the early cleavage stages of the embryo. According to HODGE IV (1933), however, HUETTNER found that later cell divisions are very irregular and this condition is retained during the later embryonic and larval development. Hence, in *Drosophila*, it is definitely known that cell divisions are not simultaneous except in the early cleavage stages.

RIPLEY (1923) studied the post-embryonic growth of Noctuid larvae and concluded that the increase from first to second stadia is usually greater and from penultimate to last more often less than that at other moults.

YAGI (1926) especially endeavoured to apply the equation of monomolecular autocatalytic chemical reaction, which had been proposed by ROBERTSON (1923, 1926) and already used by others for various vertebrates as well as some insects, to silkworms and stick insects. This rate may be defined by the equation,

$$\log \frac{x}{A-x} = k(t-t_1),$$

where x is the observed value. A the maximum growth attainable, t_1 is the time required to attain one-half the maximum growth, and k is the specific velocity constant. Applying this equation to his data on the silkworm, *Bombyx mori*, YAGI gave the conclusion that there were probably two distinct growth cycles during each period of feeding exclusive of the resting stages after and before moultings. This implies that in each larval instar there occurs the simultaneous cell division twice. The authenticity of ROBERTSON'S idea of a limiting chemical reaction has been doubted by DAVIDSON (1930), DAVENPORT (1926), and OHTA (1933) among others.

BRODY (1926, 1927), DAVIDSON (1930), HENDRICKS (1931) and others have applied successfully the following equation, accepting the idea that growth power in mammals falls off at a constant percentile rate.

$$\log W = A - be^{-kt},$$

where A is the logarithm of the weight of the animal at maturity, $100k$ is the constant percentile rate of decrease in growth power, b locates the curve in time, and W is the weight at any time t . According to WOODRUFF (1938), this equation fits the data for the roach fairly well for the early stadia but fails entirely for the later periods of life.

TITSCHACK (1926) showed in the clothes-moth, *Tineola biselliella*, that moulting does not depend upon body size, and, in fact, by changing the experimental conditions, he was able to vary the number of moults ranging from four to forty. He also showed that the increase in size becomes progressively less in succeeding moults.

BODENHEIMER (1927) used the principle of PRZIBRAM in his analysis of the linear growth of insects of different orders. Hence, some indication of the primitive number of instars in the phylogeny of a specialized species might be obtained from the increase in size per instar and an idea of latent division steps. The method of BODENHEIMER (1932, 1933) consists of dividing the final weight of each insect by 2 and the resulting figure again by 2, and so forth, until a figure corresponding to the weight of the newly hatched larva is obtained.

TOKUNAGA (1928) studied the growth of the head capsule in

the silkworm and gave the following formula for the growth of the part in question. His formula is a modification of ROBERTSON'S equation, corresponding to the first half of it. Such Japanese authors as NISHIKAWA (1931), SHIBUYA (1932) and KATO (1935) called the formula under the name TOKUNAGA'S formula.

NISHIKAWA (1931) demonstrated the excellence of the formula in the growth of the head capsule of the larva of *Chilo simplex*. SHIBUYA (1932) applied the formula to the growth of the head capsule in larvae of a Pyralid, *Ephestia cautella*.

$$\log \frac{y}{M \cdot V - y} = K(t - T),$$

where $M \cdot V$ is twice the measurement at the last instar, T the number of instars in the larval development, y the observed value at the instar t , and K is the TOKUNAGA'S constant. In his excellent studies of the chestnut weevil, *Curculio dentipes*, KATO (1935) recommended the application of TOKUNAGA'S formula to the growth of the insect and gave the opinion that it is not reasonable to consider the first larval stage and the later stages from the same point of view in the discussion of the growth, for the head size of the first larval stage has already been decided in the embryonic stage, while the growth in the later stages depends mainly upon nutrition. More recently TANAKA (1939) stated that in the larvae of *Chironomus dorsalis*, TOKUNAGA'S formula stands quite well for the growth curve of this insect. He calculated the TOKUNAGA'S constants for the width of the head and the length of the anal gill of that insect. He found that in the case of the head the deviation is very small when he excepts the first larval stage, while in the case of the anal gill the deviation is comparatively large when he excepts the first larval stage.

BACKMAN (1928) thought that the rate curve must have a maximum value and two points of inflection, beginning from the abscissa and finally becoming asymptotic to the abscissa, and found the logarithmic rate formula alone satisfactory.

In his studies on the growth of insects TEISSIER (1928) stated that the experiments hardly permit one to follow PRZIBRAM in his interpretation, and that the law proposed by PRZIBRAM is perhaps only of a certain statistical value but assuredly of no explicative value.

L'HERITIER and TEISSIER (1929) called attention to the fact that the growth is at each instant characterized by a parameter of velocity which varies only by abrupt jumps. At the beginning of each cycle one can thus conceive a sort of impulse launching growth in a direction, wherein it will persevere rigorously until there enters into play another impulse equally imperative. In this connection HODGE IV (1933) wrote a similar observation as follows. When the weight-growth curves—either the average of the individual curves—are further analysed of the rate of growth, plotted as a graph of the logarithm of the weight against percentage of the elapsed time of the preadult life, the resultant points fall onto a series of straight lines with a gradually but slightly different slope. This indicates the existence of a slightly different rate of growth specific to each instar, except the last, in which two or sometimes three different rates occur. The first one or two of these different rates of growth in the sixth instar are increasing and lead up to the pre-adult peak of excess weight at about 90 per cent of the pre-adult life-span; after which the last instar is characterized by a decreasing rate of growth.

KOGURE (1929) studied the growth curve of the silkworm and discussed the work by YAGI (1926). According to KOGURE the direct application of the formula of monomolecular autocatalytic chemical reaction to the growth of weight of the body, volume of the body and of the weight of the silk-glands is impossible and the equation may be used after certain modifications. In the fifth stage the growth of the body could not be considered as consisting of two growth cycles. At the later period of the fifth instar the growth of the silk-glands is peculiar and not parallel to that of the body. The growth in weight is not always parallel to that in volume. Contrary to YAGI's opinion that the growths of the silk-glands and other organs as well as tissues within the body are parallel to one another, the growths or impulses of certain organs may influence the harmony of the parts within the body and sometimes cause an extraordinary growth of the others as stated by DAVENPORT (1926).

ALPATOV (1929) found that in *Drosophila melanogaster* the relationship between the linear dimensions of the mouth-parts of two consecutive instars is better expressed by the coefficient $(\sqrt[3]{2})^2$ than by $\sqrt[3]{2}$.

HENSEN (1929) found that the epithelium of the mid-gut of *Vanessa*-larvae grows both by the increase in size of the cells and by the addition of new cells.

CALVERT (1929) made measurements on different species of Odonata and showed that the growth factor often varied greatly from instar to instar. He gave an excellent review of the published works on the progression factor in the growth of Arthropods, considering in turn the application of BROOK's law, DYAR's law, and the principle of PRZIBRAM as impossible.

TITSCHACK (1930) found that in the bed-bug, *Cimex lectularius*, the progression factors decreased with the age of the animal. For successive instars he obtained the values 2.50, 2.06, 1.94, and 1.76 respectively.

In his work on sawfly larvae applying DYAR's rule, TAYLOR (1931) guardedly recommended the law for corroborating the number of instars observed.

YAGI (1931) gave a list of DYAR's ratios of 75 known species of insects.

YASUMATSU (1932) investigated the growth of *Phraortes kumamotoensis* in full detail and further discussed its allometric growth.

LUDWIG (1932) studied the growth of the Japanese beetle larvae at the temperatures of 20° and 25°C, and attempted to apply PRZIBRAM's principle. Because of the range and the variation in the constants obtained, he stated that his investigations do not substantiate the principle. This conclusion was questioned by BODENHEIMER (1933). LUDWIG (1934) made a more detailed analysis of his data on the growth of the Japanese beetle, using the method for calculating latent divisions advocated by BODENHEIMER (1932, 1933). As a result of his study, LUDWIG found that, at 25°C, the observed and calculated values seldom showed a close agreement and deviations usually ranged from 10 to more than 50 per cent. However, some larvae were found whose weights showed a close agreement with those calculated when eight cell divisions were assumed, and others which fitted the calculations when only six divisions were assumed, were also discovered.

OHATA (1932) discussed the growth in organism. His discussion was based upon the cell division of bacteria. OHATA stated that the coincidence of the growth curve of organism with the curve

of ROBERTSON's monomolecular autocatalytic chemical reaction was merely accidental and the growth rate must have been discussed on the rate of cell division and the growth resistance. The growth resistance is proportional to the square of the value of growth. Thus he gave the following formula for the growth of organism,

$$\log \frac{x}{\sqrt{\frac{k}{k^1} - x^2}} = 0.4343 K (t - T).$$

YASUMATSU (1933) made a detailed analysis of the growth in weight of *Phraortes kumamotoensis* (under the name *Phraortes stomphax*), and doubted the applicability of PRZIBRAM's principle and of the equation of ROBERTSON's monomolecular autocatalytic reaction. If PRZIBRAM's principle goes true, there should occur two cell divisions in the first instar and one cell division in each of the other instars. YAGI's equation (1926) derived from ROBERTSON's monomolecular autocatalytic reaction, was almost inapplicable to the growth of the material, owing to the value assigned for A. YASUMATSU applied the logarithmic chart as a means of depicting the growth in weight and gave the following for the growth curve of each stadium of this insect.

$$\log W = a + c (x - b)^2,$$

where W is the weight of the body at any time x, and a, b and c are constants of velocity. Further YASUMATSU recognized two (♂) or three (♀) phases of growth during the post-embryonic developmental period. The earlier three instars belong to the first phase of growth, the fourth (♀) or fourth and fifth (♂) are the second phase, and fifth and sixth (♀) are the third phase. In a most ideal case the deviation between the observed and calculated values was only 0.28 per cent.

HODGE IV (1933), in *Melanoplus differentialis*, also obtained growth factors which varied greatly, ranging from 1.08 to 1.64 and questioned the applicability of PRZIBRAM's principle.

FORBES (1934) noted a falling off in the ratios of *Agrotis ypsilon* towards the end of its development and stated that there is still much room for study of the exceptions and irregularity in DYAR's law.

In the larvae of holometabolous insects, increase in the size of the body is largely due to the growth of cells rather than to

the increase in cell number. TRAGER (1934) found that in the larvae of the flesh-fly, *Lucilia sericata*, all cells except brain and blood cells increased greatly in size in growth. Moreover, for hypodermis, mid-gut, hind-gut, muscles and tracheal matrix cells, this increase was proportional to the increase in length of the body.

KNOWLTON (1934) found that the measurements of the total length and width of the potato psyllid, *Paratrioza cockerelli*, followed quite closely a geometrical progression and the individual measurements composed a distinct frequency distribution that characterized the instars.

GAINS and CAMPBELL (1935) studied the corn ear worm, *Heliothis obsoleta*, and analysed certain observed and calculated progressions in order to judge the reliability of DYAR's law for corroborating the number of instars. They did not recommend the application of DYAR's rule, for the law did not hold in that case because the progression in question became unusual. High growth ratios were often encountered in the early part of larval development, and there was a tendency in the growth ratios diminishing during larval development. Two other examples taken from the literature were given as additional evidences in which the application of DYAR's rule may indicate instars that do not exist. He stated that a curve of best fit for the case was calculated from the equation, $\log y = a + bx + cx^2$, by the method of least squares.

MURRAY and TIEGS (1935), as a result of their study on *Calandra oryzae*, and TRAGER (1935), as a result of his work on the blow-fly and the silk worm, postulated that in those tissues which pass the period from the larval to the adult condition without much change, the growth was produced by a process of cell multiplication; while in those tissues which are replaced during metamorphosis, the growth was caused by an increase in the size of the constituent cells. MURRAY and TIEGS believed that the degeneration was traceable to an extent of a great hypertrophy which the specialized larval cells underwent.

ABERCROMBIE (1936) made an extensive study on the growth of the Japanese beetle. His results were summarized as follows. The average progression factors for increase in length were found to be 2.11, 1.62 and 1.36 for the first, second, and third instars respectively. The average progression factors for increase in

weight were 6.12, 4.36, and 2.50, in the first, second, and third instars respectively. In both the cases the progression factors decreased with successive moults, contrary to PRZIBRAM's principle. Due to the vast range and variation of all of these factors it was concluded that PRZIBRAM's principle was inapplicable. Japanese beetle larvae exhibit a continuous growth with respect to the increase in weight and length, and a discontinuous growth with respect to the increase in size of the head capsule. There is no increase in the number of cells in the region of the mid-intestine and of the brain at the time of moulting. The progression in weight and length could not be considered as correlated with an increase in cell number. In the first instar the progression for increase in weight was 5.73; while for the increase in cell number, it was 1.67 for the mid-intestine, and 1.19 for the brain.

In the second instar, the corresponding figures were 5.24, 1.98 and 1.69 respectively. In the third instar weight increased 3.18 times, but there was practically no increase in cell number. Thus, moulting did not represent a definite increase in the number of cells of the insect body, contrary to the assumption suggested by PRZIBRAM and MEGUSAR (1912), and BODENHEIMER's method of calculating the number of cell divisions seemed to be supported by no factual basis. Although many mitotic figures were seen, there was nothing to affirm the simultaneous cell divisions. The increase in size of the larva was largely due to an increase in cell size. The ratio of increase in total cell volume of the columnar cells of the mid-intestine was approximately the same as the ratio for weight increase. These results were in agreement with those reported by TRAGER (1934).

LUDWIG and ABERCROMBIE (1936) made a study on the histological changes accompanying the growth of the mid-intestine of the Japanese beetle larvae. The mid-intestinal epithelium of the Japanese beetle larva is composed of columnar cells, which do not divide, and of basal or interstitial cells which divide and produce new columnar cells. These new cells become elongated and push between adjacent columnar cells. They continue to grow until they have reached the size of columnar cells already present. During the first 4 days of both the first and second instars (at 25°C) there is no increase in the number of columnar cells, the growth being due entirely to an increase in the size of the cells

already present. The number of columnar cells begins to increase about the fifth day of each instar and continues to increase until the larva prepares for the succeeding moult. Cell multiplication and differentiation occur simultaneously, and are most rapid near the end of each instar.

YAMANOUTI (1936) studied the growth of *Sphodromantis bioculata*, especially its growth in eyes. The facet number in the newly hatched larva is 3804, and 9639 in the larva after ninth moulting, the average rate being 1.12 per instar. The average growth rate of the facet-volume is 1.77, thus the growth of the eye-mass shows roughly a doubling from moult to moult.

YAMANOUTI (1936) measured the size of excrements in each instar of *Sphodromantis bioculata*, *Dixippus morosus*, *Diapheromera femorata*, *Bacillus rossi*, *Eurycnema herculeana* and *Phyllium pulchrifolium* at 23°C and showed the applicability of PRZIBRAM's principle.

HARRIES and HENDERSON (1938) studied the growth of some species of Cicadellidae and made a detailed discussion on DYAR's law. His conclusion is as follows. DYAR's criterion for the increase in head width in successive larval instars of Lepidoptera was proved to be applied for describing the progression in head width in nymphal instars of several species of Cicadellidae. An analysis of other data has shown that the principle is generally of descriptive value but exceptions to the rule are fairly common. These may be due to a regular decrease in the supposed constant value of the growth quotient in successive stages, to irregularities or breaks in the progression, or to an abrupt change in the value of growth factor which would apparently indicate the existence of two or more growth phases. The same progression relationship, with similar limitations, may be applied to the increase in weight of insects in successive instars. Variation in the value of the progression factor among different species showed that PRZIBRAM's progression principle was of doubtful significance.

WOODRUFF (1938) studied the normal growth rate of *Blattella germanica*. In plotting the curves of growth from the data obtained, he has made use of semi-log or arithlog paper to give a ratio chart and gave the following excellent formula.

$$\log W = a + bt + c \log(t+1) \\ (\text{or } W = t^c \cdot e^{bt}),$$

where W indicates the weight at any time t (in his case t is the ordinal number of the instar), a , b and c are constants of velocity.

DUARTE (1938) investigated the problem of growth of the African migratory locust, *Locusta migratoria migratorioides*, and found that DYAR's rule held good for the growth in length of the mid-femur and the width of the head. PRZIBRAM's rule, as modified by BOBENHEIMER, held true for the growth in length of the different parts and showed that the occurrence of latent cell-divisions kept fairly constant in both phases. For wet weight PRZIBRAM's principle was inapplicable owing to a large percentage of differences between the actual and calculated values. Growth ratios declined throughout the instars.

WOODRUFF (1939) studied the linear growth ratios for *Blattella germanica*, using the ratio chart and gave the following result. Increases at the moults followed the same general curve previously determined for weight, namely a constantly diminishing rate which was best defined by the equation:

$$\log L = a + bt + c \log t$$

$$(\text{or } L = t^c \cdot e^{a+bt}).$$

The pronotum was exceptional in that the growth was completed in five stadia instead of in the normal number of six.

WOODRUFF (1939) emphasized the applicability of the ratio or logarithmic chart as a means of depicting the growth in insects and gave the following opinion. Difference charts, in which the absolute values are used in plotting growth curves of insects, are unsatisfactory, since the curve has no significance when interpretations of rate are desired, showing only the changes in magnitude. On the other hand, the ratio chart, whose basic concept is that of relative rather than absolute change, indicates the true rate of growth through the comparative changes in the curvature of the line. The features of a curve which attract the greatest attention are concerned with direction or slope. These features, therefore, should not be misleading as they are in the difference chart but a true representation of the course of growth. In the ratio chart, increases or decreases are shown proportionately by a curve which denotes the trend of the growth rate accurately and clearly, uniformly being designated by a straight line. Arithmetic value may be assigned to the logarithmic ordinates, so that changes

in absolute magnitude can be easily interpreted and thus a dual purpose chart is obtained.

B. Growth in Weight within a Single Instar

1. Application of Three Formulae to the Growth Curves

Larvae of *Phraortes kumamotoensis* were used throughout the investigation, and my experimental data and some other available ones given by several authors were analyzed at the same time. Larvae were weighed on a Faraday chemical balance, sensitive to one-tenth milligram, every 24 hours from hatching to the last ecdysis. Time in days was plotted against weight in milligrams, arithmetic values being assigned to the logarithmic ordinates of the latter for ease in inspection. The detailed account and discussions may be seen in my previous paper (YASUMATSU, 1933), as well as in WOODRUFF's paper (1938). All the growth curves thus given showed a general trend, indicating a similarity in rate of growth, and the decreasing rate with days was perfectly evident. In Text-figures 25-26 were shown idealized curves of normal development for *Phraortes kumamotoensis* (modified from YASUMATSU, 1933) and *Blattella germanica* (WOODRUFF, 1938). Under standardized conditions, the growth and its rate seemed to be defined very well by the following equations:

$$\log W = a + c(x-b)^2 \dots\dots\dots \text{YASUMATSU, 1933}$$

$$\log W = a + bx + cx^2 \dots\dots\dots \text{GAINS and CAMPBELL, 1935}$$

$$\log W = a + bt + c \log(t+1) \dots\dots \text{WOODRUFF, 1938}$$

1. Growth of the second instar larva of *Phraortes kumamotoensis*, No. 1, ♀

(Data from YASUMATSU, 1933)

YASUMATSU's formula: $\log W = 2.5708 - 0.00445(t - 11.132)^2$

WOODRUFF's formula: $\log W = 1.72938 - 0.06928t + 1.5076 \log(t+1)$

GAINS and CAMPBELL's formula:

$$\log W = 2.01911 + 0.09928t - 0.00445t^2$$

Table 25. Observed and calculated values of the growth of the second instar larva of *Phraortes kumamotoensis*, No. 1, ♀.

Age	Observed weight in mg	Calculated					
		Y's formula		W's formula		GC's formula	
		Values	Deviation	Values	Deviation	Values	Deviation
1	130	130	± 0.00	130	± 0.00	130	± 0.00
2	157	158.3	- 0.82	204.2	-30.06	158.3	- 0.82
3	180	189.0	- 5.00	268.6	-49.22	189.0	- 5.00
4	210	221.0	- 5.23	313.3	-49.19	221.2	- 5.33
5	215	253.2	-17.76	321.7	-48.69	253.5	-17.90
6	250	284.1	-13.64	387.0	-54.80	284.6	-13.84
7	280	312.4	-11.57	403.5	-44.10	313.0	-11.78
8	290	336.6	-16.06	410.9	-41.68	337.3	-16.31
9	230	364.0	-58.26	410.6	-78.52	356.0	-54.78
10	320	367.3	-14.78	404.1	-26.28	368.7	-15.21
11	340	372.0	- 9.41	392.9	-15.55	373.0	- 9.70
12	390	369.3	+ 5.30	377.9	+ 3.30	397.0	- 1.79
13	360	359.1	+ 0.25	360	± 0.00	351.7	+ 2.30
14	350	341.4	+ 2.45	340.8	+ 2.62	342.8	+ 2.05
15	320	319.3	± 0.00	320	± 0.00	320.0	± 0.00
Average deviation			- 9.66		-28.81		-10.04

2. Growth of the sixth instar larva of the same species, No. 1, ♀ (Data from YASUMATSU, 1933)

YASUMATSU's formula : $\log W = 3.66485 - 0.00245 (t - 13.18)^2$

WOODRUFF's formula : $\log W = 3.09321 - 0.02494 t + 0.7732 \log (t + 1)$

GAINS and CAMPBELL's formula :

$$\log W = 3.23884 + 0.06463 t - 0.00245 t^2$$

Table 26. Observed and calculated values for the growth of the sixth instar larva of the same species, No. 1, ♀

Age	Observed weight in mg	Calculated					
		Y's formula		W's formula		GC's formula	
		Values	Deviation	Values	Deviation	Values	Deviation
1	2000	2000	± 0.00	2000	± 0.00	2000	± 0.00
2	2385	2283	+ 4.27	2583	- 8.30	2282	+ 4.31
3	2900	2576	+ 11.17	3047	- 5.06	2575	+ 11.20
4	3320	2873	+ 13.46	3418	- 2.95	2872	+ 13.49
5	3700	3170	+ 14.32	3716	- 0.43	3168	+ 14.37
6	3700	3452	+ 8.43	3971	- 5.33	3454	+ 8.38
7	3780	3726	+ 1.42	4138	- 9.47	3725	+ 1.55
8	4070	3974	+ 2.35	4281	- 5.18	3972	+ 2.40
9	4170	4188	- 0.43	4384	- 5.13	4187	- 0.47
10	4400	4366	+ 0.77	4430	- 0.68	4365	+ 0.79
11	4500	4500	± 0.00	4502	- 0.04	4500	± 0.00
12	4700	4586	+ 2.42	4520	+ 3.82	4586	+ 2.42
13	4600	4621	- 0.45	4520	+ 1.73	4621	- 0.45
14	4665	4605	+ 1.25	4501	+ 3.51	4605	+ 1.25
15	4465	4536	- 1.59	4468	- 0.06	4536	- 1.59
16	4420	4420	± 0.00	4420	± 0.00	4420	± 0.00
Average deviation		+ 3.58		- 2.09		+ 3.60	

3. Growth of the first instar larva of the same species, No. 2, ♀ (Data from YASUMATSU, 1933)

YASUMATSU's formula: $\log W = 2.2894 - 0.00259 (t - 17.396)^2$

WOODRUFF's formula: $\log W = 1.1312 - 0.05636 t + 1.715 \log (t + 1)$

GAINS and CAMPBELL's formula:

$$\log W = 1.50343 + 0.09022 t - 0.00259 t^2$$

Table 27. Observed and calculated values for the growth of the first instar larva of the same species, No. 2, ♀.

Age	Observed weight in mg	Calculated					
		Y's formula		W's formula		GC's formula	
		Values	Deviation	Values	Deviation	Values	Deviation
1	39	39.2	- 0.51	39.5	- 1.28	39.0	± 0.00
2	48	47.4	+ 1.25	66.3	-38.12	47.2	+ 1.66
3	50	56.6	-13.20	98.8	-97.60	56.3	-12.00
4	50	66.8	-33.60	127	-154.00	66.5	-33.00
5	59	82.7	-40.16	153	-161.01	77.6	-31.52
6	68	90.3	-32.79	175	-157.35	89.4	-31.47
7	73	102	-39.72	202	-176.71	102	-39.72
8	78	115	-47.43	207	-137.17	115	-47.43
9	78	128	-39.06	218	-179.47	128	-39.06
10	79	141	-78.48	226	-186.07	140	-78.48
11	92	153	-66.30	230	- 59.22	152	-65.21
12	103	164	-59.22	232	-125.24	163	-58.25
13	118	174	-47.45	231	- 95.76	173	-46.61
14	140	182	-30.00	228	- 62.85	182	-30.00
15	140	188	-34.28	224	- 60.00	188	-34.28
16	153	193	-26.14	219	- 43.13	193	-29.14
17	163	194	-19.01	207	- 26.99	194	-19.01
18	177	194	- 9.60	204	- 15.25	194	- 9.60
19	185	192	- 3.78	196	- 6.00	192	- 3.78
20	187	187	± 0.00	187	± 0.00	187	± 0.00
21	180	180	± 0.00	174	+ 3.33	180	± 0.00
22	170	171	- 0.58	169	- 0.58	172	- 1.17
23	163	162	+ 0.61	159	+ 2.45	162	+ 0.61
24	150	150	± 0.00	150	0.00	150	± 0.00
Average deviation			-25.81		-70.05		-25.21

4. Growth of the fifth instar larva of the same species, No. 3, ♀ (Data from YASUMATSU, 1933)

YASUMATSU's formula: $\log W = 3.39993 - 0.00236 (t - 11.816)^2$

WOODRUFF's formula: $\log W = 2.94622 - 0.0273 t + 0.6806 \log (t + 1)$

GAINS and CAMPBELL's formula: $\log W = 3.0707 + 0.0555 t - 0.00235 t^2$

Table 28. Observed and calculated values for the growth of the fifth instar larva of the same species, No. 3, ♀.

Age	Observed weight in mg	Calculated					
		Y's formula		W's formula		GC's formula	
		Values	Deviation	Values	Deviation	Values	Deviation
1	1330	1330	±0.00	1330	± 0.00	1330	±0.00
2	1415	1487	-5.08	1645	-16.25	1487	-5.08
3	1630	1646	-0.98	1879	-15.27	1644	-0.85
4	1880	1802	+4.14	2051	- 9.09	1800	+4.25
5	2050	1906	+7.02	2184	+ 6.53	1947	+5.02
6	2280	2090	+8.24	2278	+ 0.08	2085	+8.55
7	2330	2114	+9.27	2342	- 0.51	2208	+5.23
8	2400	2320	+3.33	2383	+ 0.70	2313	+3.62
9	2405	2405	±0.00	2405	± 0.00	2453	-1.98
10	2530	2467	+2.49	2410	+ 4.74	2458	+2.84
11	2570	2502	+2.64	2401	+ 6.57	2493	+2.99
12	2570	2511	+2.29	2380	+ 7.39	2502	+2.64
13	2585	2493	+3.75	2351	+ 9.05	2483	+3.94
14	2545	2447	+3.85	2314	+ 9.07	2438	+4.20
15	2470	2377	+3.76	2273	+ 7.97	2375	+3.84
16	2345	2284	+2.60	2222	+ 5.24	2276	+2.94
17	2170	2170	±0.00	2170	± 0.00	2163	+0.32
Average deviation			+2.77		+0.14		+2.49

5. Growth of the first instar larva of the same species, No. 4, ♀ (Data from YASUMATSU, 1933)

YASUMATSU's formula : $\log W = 2.20138 - 0.00256 (t - 17.851)^2$

WOODRUFF's formula : $\log W = 1.06706 - 0.0442 t + 1.509 \log (t + 1)$

GAINS and CAMPBELL's formula :

$$\log W = 1.38869 + 0.09098 t - 0.00255 t^2$$

Table 29. Observed and calculated values for the growth of the first instar larva of the same species, No. 4, ♀

Age	Observed weight in mg	Calculated					
		Y's formula		W's formula		GC's formula	
		Values	Deviation	Values	Deviation	Values	Deviation
1	30	29.8	+ 0.66	30	± 0.00	30	± 0.00
2	42	36.2	+13.80	49.9	-18.80	36.3	+13.57
3	46	43.3	+ 5.86	69.7	-51.52	43.5	+ 5.43
4	50	51.3	- 2.60	88.1	-76.20	51.6	- 3.20
5	55	60.1	- 9.27	105	-90.90	60.2	- 9.45
6	58	69.5	-19.82	119	-105.17	69.6	-20.00
7	65	79.4	-22.15	132	-103.07	79.5	-22.30
8	76	89.7	-18.02	142	-86.84	89.8	-18.15
9	84	101	-20.23	151	-79.76	100	-19.04
10	86	111	-29.06	157	-82.51	111	-29.06
11	98	120	-22.44	162	-65.30	120	-22.44
12	104	130	-25.00	165	-58.65	130	-25.00
13	107	138	-28.97	166	-55.14	138	-28.97
14	130	146	-12.30	167	-28.46	146	-12.30
15	140	152	- 8.57	166	-18.57	151	- 7.85
16	146	156	- 6.85	165	-13.01	157	- 7.53
17	157	158	- 0.63	162	- 3.18	158	- 0.63
18	159	159	± 0.00	159	± 0.00	159	± 0.00
19	147	158	- 7.48	155	- 5.44	157	- 6.79
20	145	152	- 4.82	151	- 4.13	154	- 6.20
21	144	150	- 4.16	143	+ 0.69	149	- 3.47
22	144	143	+ 0.69	141	+ 2.08	143	+ 0.69
23	136	136	± 0.00	136	± 0.00	136	± 0.00
Average deviation			- 9.62		-41.03		- 9.68

6. Growth of the second instar larva of the same species, No. 4, ♀ (Data from YASUMATSU, 1933)

YASUMATSU's formula: $\log W = 2.52536 - 0.0045 (t - 10.269)^2$

WOODRUFF's formula: $\log W = 1.8382 - 0.05156 t + 1.1556 \log (t + 1)$

GAINS and CAMPBELL's formula:

$$\log W = 2.04445 + 0.09366 t - 0.00456 t^2$$

Table. 30. Observed and calculated values for the growth of the second instar larva of the same species, No. 4, ♀.

Age	Observed weight in mg	Calculated					
		Y's formula		W's formula		GC's formula	
		Values	Deviation	Values	Deviation	Values	Deviation
1	136	137	- 0.73	136	± 0.00	136	± 0.00
2	136	165	-21.32	193	-41.91	163	-19.85
3	166	193	-16.26	239	-43.97	192	-15.66
4	200	223	-11.50	275	-37.50	221	-10.50
5	250	251	- 0.40	276	- 6.40	256	- 2.40
6	255	277	- 8.62	320	-25.49	276	- 8.23
7	287	300	- 4.52	331	-15.33	299	- 4.18
8	290	317	- 9.31	337	-16.20	317	- 9.31
9	340	329	+ 3.23	338	+ 0.58	329	+ 3.23
10	355	334	+ 5.91	335	± 0.00	335	+ 5.63
11	355	333	+ 6.19	329	+ 7.32	333	+ 6.19
12	333	324	+ 2.70	321	+ 3.60	324	+ 2.70
13	310	310	± 0.00	310	± 0.00	310	± 0.00
Average deviation		-4.20		-13.48		- 4.02	

7. Growth of the first instar larva of the same species, No. 5, ♀ (Data from YASUMATSU, 1933)

YASUMATSU's formula: $\log W = 2.14739 - 0.0028 (t - 16.469)^2$

WOODRUFF's formula: $\log W = 1.12626 - 0.0363 t + 1.2861 \log (t + 1)$

GAINS and CAMPBELL's formula:

$$\log W = 1.38765 + 0.09226 t - 0.0028 t^2$$

Table 31. Observed and calculated values for the growth of the first instar larva of the same species, No. 5, ♀.
(Data from YASUMATSU, 1933)

Age	Observed weight in mg	Calculated					
		Y's formula		W's formula		GC's formula	
		Values	Deviation	Values	Deviation	Values	Deviation
1	30	30	± 0.00	30.8	- 2.66	30	± 0.00
2	43	36.4	+ 15.34	46.5	- 8.13	36.4	+ 15.34
3	45	43.6	+ 3.11	62.3	- 38.44	43.6	+ 3.11
4	52	51.5	+ 0.96	75.9	- 44.03	51.5	+ 0.96
5	55	60.1	- 9.27	88.1	- 60.18	60.1	- 9.27
6	62	69.3	- 11.77	95.6	- 54.19	69.3	- 11.77
7	70	78.8	- 12.57	108.0	- 57.14	78.8	- 12.57
8	84	88.4	- 5.23	116.0	- 38.09	88.4	- 5.23
9	96	97.9	- 1.97	121.7	- 26.77	98.0	- 2.08
10	102	107	- 4.80	126.6	- 24.11	107	- 4.80
11	110	116	- 5.45	132.9	- 20.81	116	- 5.45
12	119	123	- 3.36	134.3	- 12.01	123	- 3.36
13	115	129	- 12.17	135.0	- 17.39	130	- 13.04
14	135	135	± 0.00	135.0	± 0.00	135	± 0.00
15	144	139	+ 3.47	134.2	+ 6.80	142	+ 1.39
16	146	140	+ 4.10	134.0	+ 8.21	140	+ 4.10
17	157	140	+ 10.82	132.0	+ 15.92	140	+ 10.82
18	155	138	+ 10.96	131.0	+ 15.48	139	+ 10.32
19	140	135	+ 3.57	127.9	+ 5.07	135	+ 3.57
20	135	129	+ 4.44	126.1	+ 6.59	130	+ 3.70
21	123	123	± 0.00	123.0	± 0.00	123	± 0.00
Average deviation			- 0.46		- 16.70		- 0.67

8. Growth of the second instar larva of the same species, No. 5 ♀ (Data from YASUMATSU, 1933)

YASUMATSU's formula: $\log W = 2.57081 - 0.00342 (t - 12.894)^2$

WOODRUFF's formula: $\log W = 1.7875 - 0.04076 t + 1.1399 \log (t + 1)$

GAINS and CAMPBELL's formula:

$$\log W = 2.01773 + 0.07513 t - 0.00295 t^2$$

Table 32. Observed and calculated values for the growth of the second instar larva of the same species, No. 5, ♀.

Age	Observed weight in mg	Calculated					
		Y's formula		W's formula		GC's formula	
		Values	Deviation	Values	Deviation	Values	Deviation
1	123	122	+ 0.81	123	± 0.00	123	± 0.00
2	147	146	+ 0.68	177	-20.40	151	- 2.72
3	140	176	-25.71	224	-60.00	173	- 9.28
4	180	199	-10.85	258	-43.33	201	-16.66
5	210	227	- 8.09	295	-40.47	229	- 9.04
6	240	256	- 6.66	321	-33.75	257	- 7.08
7	270	283	- 4.81	340	-25.92	284	- 5.18
8	310	308	+ 0.64	354	-12.22	310	± 0.00
9	320	330	- 3.12	363	-13.43	331	- 3.43
10	335	348	- 3.88	368	- 9.85	349	- 4.17
11	345	353	- 2.31	370	- 7.24	362	- 4.92
12	370	369	+ 0.27	369	+ 0.27	370	± 0.00
13	372	371	+ 0.26	366	+ 1.61	372	± 0.00
14	355	368	- 3.66	360	- 1.40	368	- 3.66
15	350	358	- 2.28	354	- 1.14	358	- 2.28
16	345	343	+ 0.57	345	± 0.00	343	+ 0.57
Average deviation			- 4.24		-16.71		- 4.24

9. Growth of the sixth instar larva of the same species,
No. 6, ♀ (Data from YASUMATSU, 1933)

YASUMATSU's formula: $\log W = 3.67366 - 0.00269 (t - 12.762)^2$

WOODRUFF's formula: $\log W = 3.06237 - 0.0329 t + 0.9021 \log (t + 1)$

GAINS and CAMBELL's formula:

$$\log W = 3.2348 + 0.06893 t - 0.0027 t^2$$

Table 33. Observed and calculated values for the growth of the sixth instar larva of the same species, No. 6, ♀.

Age	Observed weight in mg	Calculated					
		Y's formula		W's formula		GC's formula	
		Values	Deviation	Values	Deviation	Values	Deviation
1	2000	2002	- 0.10	2000	± 0.00	2000	± 0.00
2	2385	2302	+ 3.48	2673	-12.07	2301	+ 3.52
3	2900	2608	+10.06	3212	-10.75	2596	+10.48
4	3320	3000	+ 9.63	3641	- 9.66	2933	+11.65
5	3700	3455	+ 6.62	3980	- 7.56	3251	+12.13
6	3770	3553	+ 5.75	4240	-12.46	3558	+ 5.62
7	3780	3840	- 1.58	4433	-17.27	3846	- 1.74
8	4070	4098	- 0.51	4570	-12.28	4106	- 0.88
9	4170	4222	- 1.24	4660	-11.75	4330	- 3.83
10	4400	4499	- 2.25	4708	- 7.00	4510	- 2.50
11	4500	4627	- 2.82	4720	- 4.86	4638	- 3.06
12	4700	4699	+ 0.02	4700	± 0.00	4711	- 0.23
13	4600	4715	- 2.50	4662	- 1.30	4727	- 2.76
14	4665	4672	- 0.15	4600	+ 1.39	4684	- 0.40
15	4465	4573	- 2.41	4520	- 1.23	4584	- 2.66
16	4420	4420	± 0.00	4426	- 0.13	4430	- 0.22
Average deviation		+ 1.37		- 6.67		+ 1.57	

10. Growth of the fifth instar larva of the same species,
No. 11, ♂ (Data from YASUMATSU, 1933)

YASUMATSU's formula: $\log W = 3.50101 - 0.00386 (t - 8.9703)^2$

WOODRUFF's formula: $\log W = 3.00281 - 0.05835 t + 1.0358 \log (t + 1)$

GAINS and CAMPBELL's formula:

$$\log W = 3.18971 + 0.06942 t - 0.00387 t^2$$

Table 34. Observed and calculated values for the growth of the fifth instar larva of the same species, No. 11, ♂.

Age	Observed weight in mg	Calculated					
		Y's formula		W's formula		GC's formula	
		Values	Deviation	Values	Deviation	Values	Deviation
1	1800	1801	- 0.05	1780	+ 1.11	1800	± 0.00
2	2100	2049	- 2.42	2402	-14.38	2056	+ 2.04
3	2300	2369	- 0.39	2826	-22.86	2307	- 0.30
4	2600	2550	+ 1.92	3115	-19.80	2543	+ 2.19
5	2620	2780	- 6.10	3117	-18.58	2755	- 5.15
6	2860	2930	- 2.44	3373	-17.94	2930	- 2.44
7	2995	3063	- 2.27	3382	-12.92	3062	- 2.23
8	2970	3145	- 5.92	3345	-15.99	3143	- 5.82
9	3000	3160	- 5.33	3262	- 8.73	3170	- 5.66
10	3140	3140	± 0.00	3147	- 0.22	3140	± 0.00
11	3295	3055	+ 7.28	3012	+ 8.58	3055	- 7.27
12	3020	2915	+ 3.47	2842	+ 5.89	2921	+ 3.27
13	2860	2743	+ 4.09	2701	+ 5.55	2742	+ 4.12
14	2530	2532	- 0.07	2584	- 2.13	2530	± 0.00
Average Deviation		- 0.58		- 8.03		- 1.30	

11. Growth of the fifth instar larva of the same species,
No. 15, ♂ (Data from YASUMATSU, 1933)

YASUMATSU's formula: $\log W = 3.48105 - 0.00344 (t - 7.93)^2$

WOODRUFF's formula:

$$\log W = 3.12247 - 0.05074 t + 0.81134 \log (t + 1)$$

GAINS and CAMPBELL's formula:

$$\log W = 3.26488 + 0.05451 t - 0.00343 t^2$$

Table 35. Observed and calculated values for the growth of the fifth instar larva of the same species, No. 15, ♂.

Age	Observed weight in mg	Calculated					
		Y's formula		W's formula		GC's formula	
		Values	Deviaton	Values	Deviaton	Values	Deviaton
1	2070	2070	± 0.00	2070	± 0.00	2070	± 0.00
2	2280	2291	— 0.48	2559	—12.23	2291	— 0.48
3	2450	2497	— 1.91	2875	—17.34	2497	— 1.91
4	2630	2679	— 1.86	3066	—16.57	2679	— 1.86
5	2500	2828	—13.12	3163	—26.52	2828	—13.12
6	2660	2940	—10.52	3189	—19.88	2940	—10.52
7	3040	3006	+ 1.18	3161	—31.98	3006	+ 1.18
8	3160	3027	+ 4.33	3095	+ 2.05	3027	+ 4.33
9	3000	3000	± 0.00	3000	± 0.00	3000	± 0.00
10	2700	2930	— 8.51	2884	— 6.81	2926	— 8.37
11	2700	2814	— 4.22	2753	— 1.96	2810	— 4.07
12	2490	2661	— 6.86	2614	— 4.97	2655	— 6.62
13	2470	2470	± 0.00	2470	± 0.00	2470	± 0.00
Average deviation		— 3.22		— 8.32		— 3.19	

12. Growth of the mid-intestine of the first instar larva of
Popillia japonica (Data from LUDWIG and ABERCROMBIE, 1936)

YASUMATSU's formula: $\log W = 2.1673 - 0.0036 (t - 15.991)^2$

WOODRUFF's formula:

$$\log W = -0.21458 - 0.01760 t + 1.3423 \log (t + 1)$$

GAINS and CAMPBELL's formula:

$$\log W = 0.27217 + 0.10836 t - 0.00327 t^2$$

Table 36. Observed and calculated values for the growth of the mid-intestine of the first instar larva of *Popillia japonica*.

Age	Observed weight in mg	Calculated					
		Y's formula		W's formula		GC's formula	
		Values	Deviation	Values	Deviation	Values	Deviation
1	2.8	2.87	- 2.50	1.49	+46.78	2.38	+15.00
2	3.0	2.9	+ 3.33	2.45	+18.33	2.99	+ 0.33
3	3.6	3.6	± 0.00	3.5	+ 2.77	3.7	- 2.77
4	4.5	4.5	± 0.00	4.5	± 0.00	4.5	± 0.00
5	5.5	5.4	+ 1.81	5.5	± 0.00	5.4	+ 1.81
6	6.3	6.4	- 1.58	6.5	- 3.17	6.4	- 1.58
7	7.6	7.5	+ 1.31	7.5	+ 1.31	7.4	+ 2.63
8	8.6	8.6	± 0.00	8.4	+ 2.32	8.5	+ 1.16
9	10.3	9.8	+ 4.85	9.3	+ 9.70	9.6	+ 6.79
10	11.3	10.9	+ 4.76	10.1	+10.61	10.6	+ 6.19
11	13.3	12.0	+ 9.77	10.9	+18.04	11.6	+12.78
12	13.1	12.9	+ 1.52	11.5	+12.21	12.6	+ 3.81
13	14.8	13.7	+ 7.43	12.4	+16.21	13.4	+ 9.45
14	14.3	14.2	+ 0.69	13.1	+ 8.32	14.0	+ 2.09
15	16.0	14.6	+10.00	13.7	+14.37	14.4	+10.00
16	14.7	14.2	+ 3.40	14.1	+ 4.08	14.7	± 0.00
Average deviation			+ 3.11		+10.11		+ 4.23

13. Growth of the mid-intestine of the second instar larva of the same species (Data from LUDWIG and ABERCROMBIE, 1936)

YASUMATSU's formula: $\log W = 2.90692 - 0.0042 (t - 14.19)^2$

WOODRUFF's formula:

$$\log W = 0.69168 - 0.0274 t + 1.3566 \log (t + 1)$$

GAINS and CAMPBELL's formula:

$$\log W = 0.98504 + 0.13215 t - 0.00472 t^2$$

Table 37. Observed and calculated values for the growth of the mid-intestine of the second instar larva of the same species.

Age	Observed weight in mg	Calculated					
		Y's formula		W's formula		GC's formula	
		Values	Deviation	Values	Deviation	Values	Deviation
1	15.6	15.0	+ 3.84	11.5	+26.28	12.9	+17.30
2	17.0	18.8	-10.58	18.8	-10.58	17.0	± 0.00
3	20.8	24.0	-15.38	26.1	-25.48	21.3	- 2.40
4	24.5	29.6	-20.81	31.1	-26.93	27.4	-11.83
5	33.4	35.7	- 6.88	39.8	-19.16	33.8	- 1.19
6	41.6	42.2	- 1.44	46.1	-10.81	40.5	+ 2.64
7	38.0	49.0	- 2.63	51.9	-36.57	47.7	-25.52
8	57.9	56.8	+ 1.89	57.2	+ 1.20	54.9	+ 5.18
9	61.9	62.2	- 0.48	61.9	± 0.00	62.3	- 0.64
10	53.3	68.1	-27.76	66.1	-24.01	68.2	-27.95
11	85.3	73.2	+14.18	69.9	+18.05	73.6	+13.71
12	75.7	77.1	- 1.84	73.1	+ 3.43	77.7	- 2.64
13	97.9	79.6	+18.69	75.9	+22.47	80.4	+17.87
14	92.7	80.7	+12.94	78.3	+15.53	81.1	+12.51
15	80.2	80.2	± 0.00	30.2	± 0.00	80.2	± 0.00
Average deviation			-2.41		- 4.17		→ 0.20

14. Growth of the fifth instar larva of *Bombyx mori*,
Kokusan-niti-no. 107 (Data from KOGURE, 1929)

YASUMATSU's formula: $\log W = 2.4372 - 0.0489 (t - 4.654)^2$

WOODRUFF's formula: $\log W = 0.92026 - 0.24614 t + 3.5235 \log (t + 1)$

GAINS and CAMPBELL's formula: $W = 1.37656 + 0.45576 t - 0.04896 t^2$

Table 38. Observed and calculated values for the growth of the fifth instar larva of *Bombyx mori*, Kokusan-niti-no. 107.

Age	Observed weight in g	Calculated					
		Y's formula		W's formula		GC's formula	
		Values	Deviation	Values	Deviation	Values	Deviation
1	0.69	0.61	+11.59	0.54	+21.73	0.61	+11.59
2	0.97	1.23	-26.80	1.29	-32.98	1.23	-26.80
3	2.01	2.01	± 0.00	2.01	± 0.00	2.01	± 0.00
4	2.56	2.61	- 1.95	2.45	+ 4.29	2.61	- 1.95
5	2.70	2.70	± 0.00	2.70	± 0.00	2.70	± 0.00
Average deviation			+ 2.63		-1.39		-3.43

15. Growth of the fifth instar larva of *Bombyx mori*,
Kokusan-niti-no. 1 (Data from KOGURE, 1929)

YASUMATSU's formula: $\log W = 2.4599 - 0.0165 (t - 6.7732)^2$

WOODRUFF's formula: $\log W = 1.5353 - 0.0425 t + 1.381 \log (t + 1)$

GAINS and CAMPBELL's formula :

$$\log W = 1.70204 + 0.2229 t - 0.01645 t^2$$

Table 39. Observed and calculated values for the growth of the fifth instar larva of *Bombyx mori*, Kokusan-niti-no. 1.

Age	Observed weight in g	Calculated					
		Y's formula		W's formula		GC's formula	
		Values	Deviation	Values	Deviation	Values	Deviation
1	0.81	0.81	±0.00	0.81	± 0.00	0.81	± 0.00
2	1.12	1.20	-7.14	1.29	-15.17	1.20	- 7.14
3	1.86	1.68	+9.62	1.74	+ 6.52	1.67	+10.21
4	2.14	2.14	±0.00	2.14	± 0.00	2.14	± 0.00
5	2.61	2.56	+1.91	2.50	+ 4.21	2.54	+ 2.68
6	2.80	2.80	±0.00	2.80	± 0.00	2.80	± 0.00
Average deviation			+0.87		- 0.89		+ 1.15

16. Growth of the fifth instar larva of *Bombyx mori*,
Aojuku, ♂ (Data from YAGI, 1926)

YASUMATSU's formula: $\log W = 3.42309 - 0.0277 (t - 5.615)^2$

WOODRUFF's formula: $\log W = 2.39765 - 0.06217 t + 1.6511 \log (t + 1)$

GAINS and CAMPBELL's formula:

$$\log W = 2.54844 + 0.31182 t - 0.02775 t^2$$

Table 40. Observed and calculated values for the growth
of the fifth instar larva of *Bombyx mori*, Aojuku, ♂.

Age	Observed weight in g	Calculated					
		Y's formula		W's formula		GC's formula	
		Values	Deviation	Values	Deviation	Values	Deviation
1	0.680	0.681	- 0.14	0.680	± 0.00	0.680	± 0.00
2	1.151	1.151	± 0.00	1.151	± 0.00	1.151	± 0.00
3	1.590	1.712	- 7.67	1.594	- 0.25	1.714	- 7.79
4	1.800	2.243	-24.61	2.009	-11.61	2.247	-26.50
5	2.400	2.585	- 7.70	2.358	+ 1.75	2.592	- 8.00
6	2.630	2.624	+ 0.22	2.630	± 0.00	2.632	- 0.07
Average deviation			- 6.65		- 1.68		- 7.06

17. Growth of the fifth instar larva of *Bombyx mori*,
Aojuku B, ♀ (Data from KOGURE, 1929)

YASUMATSU's formula: $\log W = 3.4784 - 0.0251 (t - 5.919)^2$

WOODRUFF's formula: $\log W = 2.40342 - 0.07488 t + 1.8039 \log (t + 1)$

GAINS and CAMPBELL's formula:

$$\log W = 2.59972 + 0.29692 t - 0.02507 t^2$$

Table 41. Observed and calculated values for the growth of the fifth instar larva of *Bombyx mori*, Aojuku B, ♀.

Age	Observed weight in mg	Calculated					
		Y's formula		W's formula		GC's formula	
		Values	Deviation	Values	Deviation	Values	Deviation
1	744	743	+0.13	744	± 0.00	744	±0.00
2	1310	1239	+5.42	1301	+ 0.68	1240	+5.34
3	1840	1840	±0.00	1840	± 0.00	1840	±0.00
4	2360	2432	-2.96	2598	-10.08	2433	-3.09
5	2770	2866	-3.42	2708	+ 2.23	2868	-3.53
6	3010	3010	±0.00	3010	± 0.00	3010	±0.00
Average deviation		-0.13		- 1.19		-0.21	

2. Considerations

Examinations of these growth curves show that the growth curve of insects may be regarded as representing a locus of a parabola in each instar, and each parabola characteristic to each instar of insects takes a similar shape with one another. There is an initial portion wherein the growth is most rapid, the velocity becomes gradually decreasing through greater part of time consumed in each instar. Then losses in weight prior to ecdysis are to be expected, causing slumps in the curve. As seen in the comparisons between the observed and calculated values, these three formulae representing a parabola may be applied equally well to the growth of not only paurometabolous insects but also holometabolous ones. Among seventeen applications of these formulae as mentioned above the equation given by WOODRUFF did not often show so close agreement between the calculated and observed values as the other two, the average error of estimate being 14.08 in value. Here we must remember that the equation given by him was not originally applied to the growth curve in each instar but to the curve representing the maximum weights in all the stadia.

C. Growth in Weight during the Post-embryonic Developmental Period

1. Application of Three Formulae to the Growth Curves

In this chapter the change of the special characters such as maximum weight and moulting weight during the post-embryonic developmental period was studied. Theoretically the maximum weight represents the maximum body-weight in each instar and is reached in the later period of the instar just before ecdysis. The moulting weight is the minimum weight at the beginning of each instar and may be definitely lower than the maximum in the preceding instar. We may be able to regard such weights as critical points. Of course the minimum weight must be selected as a more preferable criterion for the discussion of any growth curve than the maximum weight which is much more variable as compared with the former. The detailed report and discussions on this account were given in my previous paper (YASUMATSU, 1933). Here, the three formulae used in the preceding chapter were once more applied to the data of *Phraortes kumamotoensis* and *Blattella germanica* in order to determine their applicability. Under standardized conditions the locus of critical points seemed to be well defined by the three formulae.

I. Growth of *Phraortes kumamotoensis*, No. 1, ♀

(Data from YASUMATSU, 1933)

YASUMATSU's formula: $\log W = 6.82736 - 0.0000304 (t - 412.47)^2$

WOODRUFF's formula: $\log W = 1.24095 + 0.018147 t + 0.404 \log (t + 1)$

GAINS and CAMPBELL's formula:

$$\log W = 1.651924 + 0.025155 t - 0.000031 t^2$$

Table 42. Observed and calculated values for the growth of *Phraortes kumamotoensis*, No. 1, ♀.

Age	Observed weight in gm	Calculated					
		Y's formula		W's formula		GC's formula	
		Values	Deviation	Values	Deviation	Values	Deviation
22	155	155	± 0.00	155	± 0.00	155	± 0.00
37	390	348	+10.76	355	+ 8.89	347	+11.05

51	820	717	+12.56	722	+11.82	715	+12.82
63	1300	1300	± 0.00	1300	± 0.00	1300	± 0.00
77	2550	2548	+ 0.07	2527	+ 0.90	2541	+ 0.35
91	4850	4850	± 0.00	4850	± 0.00	4834	+ 0.32
Average deviation			+ 3.88		+ 3.60		+ 4.09

2. Growth of the same species, No. 2, ♀
(Data from YASUMATSU, 1933)

YASUMATSU's formula: $\log W = 4.457622 - 0.0000695 (t - 197.86)^2$

WOODRUFF's formula: $\log W = 0.91088 + 0.01186 t + 0.8499 \log (t + 1)$

GAINS and CAMPBELL's formula:

$$\log W = 1.76154 + 0.026815 t - 0.000065 t^2$$

Table 43. Observed and calculated values for the growth of the same species, No. 2, ♀.

Age	Observed weight in mg	Calculated					
		Y's formula		W's formula		GC's formula	
		Values	Deviation	Values	Deviation	Values	Deviation
20	187	187	± 0.00	187	± 0.00	187	± 0.00
34	455	389	+14.50	423	+ 7.03	397.9	+12.54
50	935	867	+ 7.27	902	+ 3.52	870.5	+ 6.89
63	1560	1560	± 0.00	1560	± 0.00	1560	± 0.00
81	2700	3226	-19.48	3148	-16.59	3214	-19.03
95	5276	5276	± 0.00	5276	± 0.00	5276	± 0.00
Average deviation			+ 0.38		- 1.00		+0.066

3. Growth of the same species, No. 3, ♂
(Data from YASUMATSU, 1933)

YASUMATSU's formula: $\log W = 3.49236 - 0.000171 (t - 105.282)^2$

WOODRUFF's formula: $\log W = 0.22768 + 0.004159 t + 1.514 \log (t + 1)$

GAINS and CAMPBELL's formula:

$$\log W = 1.65417 + 0.036001 t - 0.000171 t^2$$

Table 44. Observed and calculated values for the growth of the same species, No. 3, ♂.

Age	Observed maximum weight in mg	Calculated					
		Y's formula		W's formula		GC's formula	
		Values	Deviation	Values	Deviation	Values	Deviation
19	189	186	+1.58	189	± 0.00	189	±0.00
32	390	428	—9.74	457	—17.18	427	—9.48
47	930	930	±0.00	932	— 0.21	930	±0.00
62	1643	1694	—3.10	1621	+ 1.33	1694	—3.10
77	2585	2585	±0.00	2590	— 0.19	2585	±0.00
Average deviation			—2.25		— 3.25		—2.51

4. Growth of the same species, No. 4, ♂
(Data from YASUMATSU, 1933)

YASUMATSU's formula: $\log W = 3.7105 - 0.0001285 (t - 126.326)^2$

WOODRUFF's formula: $\log W = 0.667 + 0.00923 t + 1.07 \log (t + 1)$

GAINS and CAMPBELL's formula:

$$\log W = 1.65644 + 0.03259 t - 0.0001286 t^2$$

Table 45. Observed and calculated values for the growth of the same species, No. 4, ♂.

Age	Observed maximum weight in mg	Calculated					
		Y's formula		W's formula		GC's formula	
		Values	Deviation	Values	Deviation	Values	Deviation
18	159	159	±0.00	159	±0.00	159	±0.00
32	355	369	—3.94	387	—9.01	378	—6.47
46	760	761	—0.13	760	±0.00	778	—2.38
61	1390	1452	—4.46	1405	—1.08	1465	—5.39
75	2355	2355	±0.00	2353	+0.08	2384	—1.21
Average deviation			—1.70		—2.00		—3.09

5. Growth of the same species, No. 5, ♂

(Data from YASUMATSU, 1933)

YASUMATSU's formula: $\log W = 3.73742 - 0.000118 (t - 131.137)^2$

WOODRUFF's formula:

$$\log W = 0.823296 + 0.009832 t + 0.96132 \log (t + 1)$$

GAINS and CAMPBELL's formula:

$$\log W = 1.702458 + 0.031032 t - 0.000118 t^2$$

Table 46. Observed and calculated values for the growth of the same species, No. 5, ♂.

Age	Observed maximum weight in mg	Calculated					
		Y's formula		W's formula		GC's formula	
		Values	Deviation	Values	Deviation	Values	Deviation
17	157	156	+ 0.63	156	+0.63	157	± 0.00
33	372	385	— 3.49	389	—4.56	396	— 6.45
47	795	798	— 0.30	799	—0.50	795	± 0.00
63	1380	1547	—12.10	1510	—9.42	1545	—11.95
74	2250	2250	± 0.00	2250	±0.00	2251	— 0.04
Average deviation			— 3.07		—2.77		— 3.68

6. Growth of *Blattella germanica*, ♂

(Data from WOODRUFF, 1938)

YASUMATSU's formula: $\log W = 2.112759 - 0.000245 (t - 87.35)^2$

WOODRUFF's formula:

$$\log W = -0.0834 + 0.015633 t + 0.630123 \log (t + 1)$$

GAINS and CAMPBELL's formula:

$$\log W = 0.246067 + 0.042178 t - 0.000233 t^2$$

Table 47. Observed and calculated values for the growth of *Blattella germanica*, ♂.

Age	Observed maximum weight in mg	Calculated					
		Y's formula		W's formula		GC's formula	
		Values	Deviation	Values	Deviation	Values	Deviation
3.7	2.5	2.5	± 0.00	2.5	± 0.00	2.5	± 0.00
10.0	5.1	4.4	+13.72	5.4	-5.88	4.4	+13.72
17.0	9.1	7.9	+13.19	9.4	-3.29	7.9	+13.19
26.8	16.7	16.4	+ 1.79	17.6	-5.38	16.2	+ 2.99
36.6	30.3	28.5	+ 5.94	30.3	± 0.00	30.0	+ 0.99
48.5	55.3	55.3	± 0.00	55.3	± 0.00	55.4	- 0.18
Average deviation		+ 5.77		-2.42		+5.11	

7. Growth of the same species, ♀

(Data from WOODRUFF, 1938)

YASUMATSU's formula: $\log W = 2.17599 - 0.00032 (t - 78.102)^2$

WOODRUFF's formula:

$$\log W = -0.078719 + 0.02002 t + 0.60215 \log (t + 1)$$

GAINS and CAMPBELL's formula:

$$\log W = 0.224563 + 0.050078 t - 0.000322 t^2$$

Table 48. Observed and calculated values for the growth of the same species, ♀.

Age	Observed maximum weight in mg	Calculated					
		Y's formula		W's formula		GC's formula	
		Values	Deviation	Values	Deviation	Values	Deviation
3.9	2.6	2.6	± 0.00	2.6	± 0.00	2.6	± 0.00
9.2	5.1	4.5	+11.76	4.0	+21.56	3.6	+29.41
15.7	9.9	8.5	+14.14	9.3	+ 6.45	8.5	+14.14
24.7	18.4	18.3	+ 0.54	18.4	± 0.00	18.4	± 0.00
34.1	35.5	36.0	- 1.40	57.6	-62.25	36.1	- 1.69
45.4	68.2	68.2	± 0.00	68.2	± 0.00	68.2	± 0.00
Average deviation		+ 4.17		- 5.70		+ 7.14	

8. Growth of the same species, ♀

(Data from WOODRUFF, 1938)

YASUMATSU's formula: $\log W = 1.93203 - 0.000371 (t - 71.002)^2$

WOODRUFF's formula:

$$\log W = -0.44492 + 0.016771 t + 0.82891 \log (t + 1)$$

GAINS and CAMPBELL's formula:

$$\log W = 0.04679 + 0.053138 t - 0.000347 t^2$$

Table 49.— Observed and calculated values for the growth of the same species, ♀.

Age	Observed maximum weight in mg	Calculated					
		Y's formula		W's formula		GC's formula	
		Values	Deviation	Values	Deviation	Values	Deviation
5.8	2.2	2.2	± 0.00	2.2	± 0.00	2.2	± 0.00
11.0	4.6	3.9	+15.21	3.5	+23.9	3.8	+17.39
17.5	9.0	7.4	+17.77	7.9	+12.22	7.3	+18.88
27.1	16.3	16.5	- 1.22	16.2	+ 0.61	16.3	± 0.00
37.0	32.1	31.9	+ 0.62	30.5	+ 4.98	31.7	+ 1.24
49.4	57.4	57.4	± 0.00	57.2	+ 0.34	57.4	± 0.00
Average deviation			+ 5.39		+ 6.90		+ 6.25

2. Considerations

As seen in the comparisons between the observed and calculated values, these three formulae of a parabola may be applied equally well to the growth of paurometabolous insects. I attempted to apply PRZIBRAM's principle to my results. Because of the diverse range and the variation in the constants obtained, the investigations on *Phraortes kumamotoensis* did not substantiate the principle. The data obtained by PRZIBRAM and MEGUSAR (1912) on *Sphodromantis bioculata* (= *viridis*) are doubtful, as the weight of the moulted insects showed a doubling value from moult to moult.

D. Discussions

In 1933 HODGE IV analysed the rate of growth of *Melanoplus differentialis* by plotting and making a graph of the logarithm of the weight against percentage of the elapsed time of the pre-adult life. His results showed that the resultant points fall onto a series of straight lines of slightly differing slopes. The data indicates a slightly different rate of growth specific to each instar, except the last, in which two or even three rates occur. But the figure given by him as representing an average growth rate curve is too artificial or simplified for indicating the true nature of the curve in each instar, but is very interesting as it is demonstrating a general trend of the locus connecting some critical points. From this curve we can expect the existence of several growth phases in the post-embryonic developmental period. But his curve seems to be too weak to elucidate the relationship until much more evidences in regard to the structural knowledge during the larval stadia have been accumulated.

WOODRUFF (1938) is the first entomologist who applied the equation of a parabola to the growth curve of insects in foreign countries. From his opinion the following lines may be cited here. "Whatever the cause of the variations from day to day, their effect is observed by inexorable growth, and a smoother curve results. Freed of distracting waves, the line appears in its true light as a slight downward curve. Of course, the retrogressions preceding each moult interrupt the continuity, but even so the slightly decreasing rate is apparent. When the points representing either the maximum weight or the moulting weight are connected by a continuous line, the character of the changing velocity is unmistakable." Thus in deriving a formula whose constants would best represent the data, the observations for the maximum weights of the stadia were submitted to the equation $\log W = a + bt + c \log (t+1)$.

Apparently his observation was especially concentrated to the consideration of a locus of the maximum weights of the stadia, and, on the contrary, the minimum weights received little attention by him. The lack of any allometric study upon the material seems to suggest nothing about the growth phases which are

sometimes existing in animals. But in many growth curves demonstrated in his paper, I want to recognize two or three growth phases in *Blattella germanica*. As early as 1933, entirely independent of the work of HODGE IV, I published the results of my study on *Phraortes kumamotoensis*. My results showed that the growth of the material may be satisfactorily illustrated by a series of parabolic curves of a similar type and the critical points came onto two or three different straight lines.

The weight growth of the male may be separable into two phases, and those of the female being in three phases. The first phase lasts from hatching to the third ecdysis, and the critical points ride on a straight line $y = \tan \theta' \cdot x + l$. The second phase represents the fourth and fifth instars in the male and the fourth in the female, and the critical points are on a straight line $y = \tan \theta'' \cdot x + m$. The third phase represents the fifth and sixth instars in the female, and the critical points ride on a straight line $y = \tan \theta''' \cdot x + n$. Among these angles, θ' , θ'' and θ''' , the following relations may be recognizable. $90^\circ > \theta' > 0^\circ$, $90^\circ > \theta'' > 0^\circ$, $90^\circ > \theta''' > 0^\circ$, $\theta' = \theta'''$, $\theta' \neq \theta'''$ or $\theta' > \theta'''$, $\theta' > \theta''$, $\theta''' > \theta''$, $\theta'' (\delta) > \theta'' (\varphi)$. Such a phenomenon as seen in the female will be explained partly by the growth of the ovaries and the accumulation of the fatty bodies in the course of the larval growth. In this connection it is very interesting to note that the linear growth of the abdomen is divided into two phases as indicated in my previous study (YASUMATSU, 1932).

Though the growth phases in the sense of the growth in length and growth in weight do not coincide with each other, such a non-coincidence is not worthy of wonder. The only coincidence of the data in the length of the abdomen and the weight of the body is of extremely valuable in considering the change of the weight during the larval stadia.

General observation on the critical points indicates that the curve may be illustrated very well by the parabolic equations as applied in the preceding paragraph, but the closer investigation may afford the growth of my material with two (δ) or three (φ) phases. In this connection it must not be forgotten to notice that the three entomologists, myself (1933), HODGE IV (1933) and WOODRUFF (1938), have made use of semi-log method of plotting of the curves of growth from the data obtained in three different species of insects, and the growth curves were detected immedi-

ately with no danger of misinterpretation. From the method by the plotting of definite fractions of the total growth against definite fractions of the time consumed in completing the growth, we can get the curve showing only the change in magnitude, though the curve has no significance when interpretations of the rate are desired. Further the curves pictured by the method to take the instars with the same interval on the abscissa against definite fractions of the total growth are arbitrary and fail in showing the true growth rates.

E. Summary

1. The growth of larvae of *Phraortes kumamotoensis*, *Popillia japonica*, *Bombyx mori* and *Blattella germanica* were studied with regard to weight in the course of the post-embryonic developmental period.
2. The literature concerning the growth in weight and length was reviewed.
3. In every case the progression factors decreased with succeeding moults, contrary to PRZIBRAM's principle.
4. The absolute values must not be used in plotting growth curves of insects. Because the curves thus pictured only show the changes in magnitude.
5. Arithmetic values must be assigned to the logarithmic ordinate. By the aid of semi-log method only we may be able to illustrate the true rate of growth by the comparative changes in the curvature of the line.
6. The growth curves of insects take the type of a parabola in each instar. This may be a general trend in all the curves indicating a similarity in rate of growth, though retardations or retrogressions in the rate will be often noted between two ecdyses, more frequently in the later stadia.
7. Under standardized conditions, the growth and its rate are well defined by the equations $\log W = a + c(x-b)^2$ (for the stick insect by YASUMATSU, 1933), $\log W = a + bx + cx^2$ (for the corn ear worm by GAINS and CAMPBELL, 1935) and $\log M = a + bt + c \log(t+1)$ (for the roach by WOODRUFF, 1938). These parabolic equations may be applicable to many

other species of both paurometabolous and holometabolous insects.

8. Of the two critical points on the growth curves of insects, the minimum weight must be selected for the discussion of

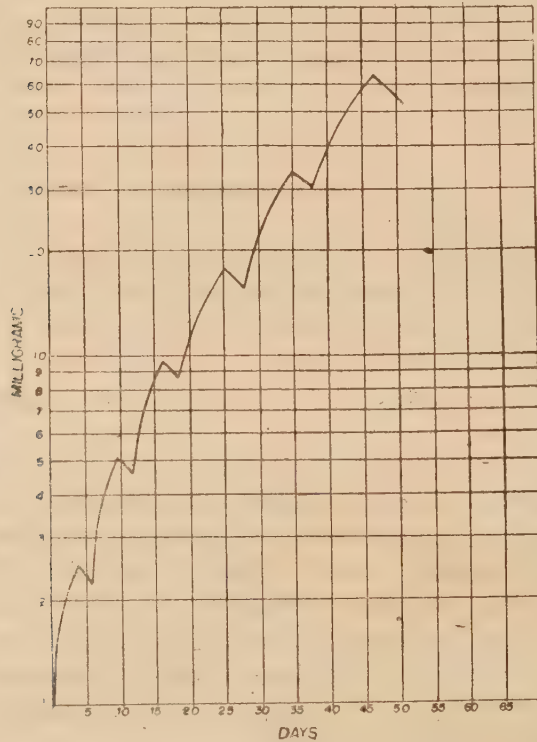


Fig. 25. An idealized curve of normal development for both sexes of *Blattella germanica* (After WOODRUFF, 1938).

any growth curve rather than the maximum weight. The minimum weight is the moulting weight at the beginning of each instar, the maximum weight is much more variable as it is influenced by a changing environment.

9. Under standardized conditions the locus of critical points is well defined by the equations given above.
10. The growth of *Phraortes kumamotoensis* may be divided into two (δ) or three (φ) growth phases. This evidence is highly

correlated with the linear growth of the allometric organs. The first, second and third instars are all included in the first growth phase. The fourth (♀) or fourth and fifth (♂) instars represent the second growth phase. The rate of the growth in the second phase is slowest with respect to the increase in weight of the body. The fact seems to be illustrated by the changes of some morphological characters as well as the differentiation of such inner organ as the reproductive system and the temporary consumption of fatty body for the activating of the former.

11. The knowledge based upon the allometric study of any of the skeletal structures in insects seems to be very neces-

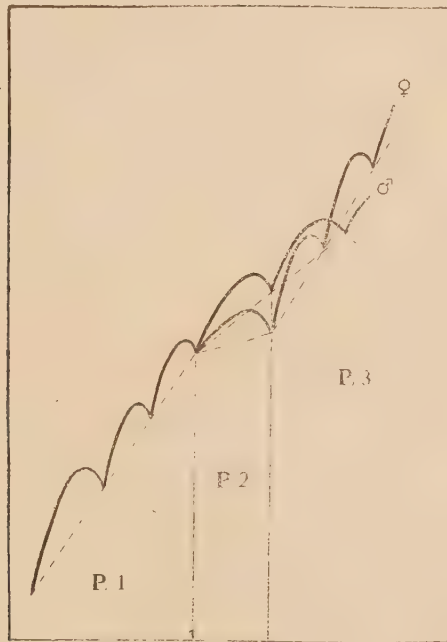


Fig. 26. An idealized curve of normal development for both sexes of *Phraortes kumamotoensis* (Modified from YASUMATSU, 1933). P. 1: The first phase. P. 2: The second phase. P. 3: The third phase.

sary and important for the unmistakable analyses of the growth in weight during the larval stadia.

VI. FOOD CONSUMPTION

A. Food Plants and Feeding Habits

Among the Phasmidae of Japan, Corea and Micronesia *Phraortes kumamotoensis* SHIRAKI is the most wide-ranging plant-feeder, while the other species show comparatively a narrower range of food plants, e.g. *Acanthograeffea denticulata* REDTENBACHER on *Cocos nucifera* LINNE; *Micadina yasumatsui* SHIRAKI and *M. fluctu-enoides* (REHN) on *Castanea crenata* SIEBOLD et ZUCCARINI, *Quercus acutissima* CARRUTHERS and *Pasania* sp.; *M. rotundata* SHIRAKI on *Pasania* sp.; *Phraortes elongatus* (THUNBERG) on *Zelkova serrata* MAKINO, *Kerria japonica* DC., *Wistaria floribunda* DC. and *W. brachybotrys* SIEBOLD et ZUCCARINI; *Phraortes formosanus* SHIRAKI on *Gossypium indicum* LAM.; *Sipyloidea sipyulus* (WESTWOOD) on *Gossypium indicum* LAM., *Megacrania tsudai* SHIRAKI on *Pandanus* sp.

Following is a list of the food plants of *Phraortes kumamotoensis* SHIRAKI. However, this shows merely some examples of the food plants, and by further researches the number of plants as food of this Phasmid may attain several hundreds.

Rosaceae

1. *Rosa polyantha* SIEBOLD et ZUCCARINI
2. *Rosa microphylla* ROXBURGH
3. *Pyrus autumnalis* var. *culta* KOIDZUMI
4. *Malus pumila* MILLER
5. *Prunus mume* SIEBOLD et ZUCCARINI
6. *Prunus salicina* LINDLEY
7. *Prunus Persica* var. *vulgaris* MAXIMOWICZ
8. *Prunus Ansu* KOMAROV
9. *Prunus subhirtella* MIQUEL
10. *Prunus serrulata* var. *spontanea* MAKINO
11. *Kerria japonica* A. P. DE CANDOLLE
12. *Amelanchier asiatica* ENDLICHER

Papilionaceae

13. *Lespedeza bicolor* var. *japonica* NAKAI
14. *Robinia pseudoacacia* LINNE

Polygonaceae

- 15. *Peynoutria japonica* HOUTTUYN
- 16. *Polygonum tenuiflora* HARA

Araliaceae

- 17. *Hedera Tobleri* NAKAI

Caprifoliaceae

- 18. *Viburnum japonicum* SPRENGEL

Ardisiaceae

- 19. *Bladhia japonica* THUNBERG

Rhodoraceae

- 20. *Lyonia Neziki* NAKAI et HARA

Celastraceae

- 21. *Celastrus orbiculatus* THUNBERG
- 22. *Euonymus japonicus* THUNBERG

Ulmaceae

- 23. *Zelkova serrata* MAKINO

Fagaceae

- 24. *Castanea crenata* SIEBOLD et ZUCCARINI
- 25. *Quercus serrata* THUNBERG
- 26. *Quercus acutissima* CARRUTHERS

Such plants as those having thick, tough, ciliate, downy, bristly, pubescent, tomentous or floccous leaves are usually free from attack of this Phasmid.

During the past twelve years, *Rosa polyantha* (Rosaceae), *Prunus Persica* (Rosaceae), *Prunus subhirtella* (Rosaceae), *Amelanchier asiatica* (Rosaceae), *Lespedeza bicolor* (Papilionaceae), *Viburnum japonicum* (Caprifoliaceae), *Lyonia Neziki* (Rhodoraceae), *Celastrus orbiculatus* (Celastraceae) and *Castanea crenata* (Fagaceae) have been used in rearing *Phraortes kumamotoensis*. In each cases,

records of the number of larvae surviving at each instar, and the length and weight of the insects at the completion of the growth were made. The result of these studies showed that all of these plants were good and quite satisfactory foods for completing the development and metamorphosis, most larvae completed any given stage at approximately the same time and secured definite size and weight, and practically no sensible differences were observed in from the results in question mentioned above, and thus revealed the fact that this Phasmid was one of the best material in studying the minimum adequate amount of food in order to complete the normal development.

In feeding on the foliage of most plants the Phasmid is an edge feeder and not surface feeder, cutting off strip after strip of leaf and swallowing them down whole. When young the bite is clean and the veins are mostly avoided, as age increases it becomes jagged and rough and the veins are no more avoided. When decay approaches they often have difficulty in making the final bite to release the strip, and then when it moves the head backwardly the whole strip reappears out of its mouth still attached to the leaf. As in the other species of the Phasmidae this species is not gregarious but solitary in habit, as indicated by the fact that when one or more insects start to feed on a given foliage in a small rearing cage, other insects never respond to collect or feed on that plant but they feed at any time when they want. Thus the time of feeding of an individual in one day is independent of chemical changes of the fluid within the foliage of plants. Attempt was made to find how many times a day the insect takes food and the interval of the two consecutive feedings. In general the insect feeds three or four times a day. In the following I give an example of a single adult individual (♀).

14.00	Observation begun.	}	5.0 units of leaves taken.
14.15	Evacuated.		
14.30	Evacuated.		
14.45	Evacuated.		
15.02	Began to feed.		
15.15	Evacuated.	}	
15.37	Stopped to feed.		
16.00	Evacuated.		

16.10	Evacuated.	
16.30	Evacuated.	
16.55	Evacuated.	
17.18	Evacuated.	
17.40	Evacuated.	
18.00	Evacuated.	
18.15	Evacuated.	
18.42	Evacuated.	
18.58	Evacuated.	About 347 minutes.
19.16	Evacuated.	
19.35	Evacuated.	
19.50	Evacuated.	
20.10	Evacuated.	
20.30	Evacuated.	
20.50	Evacuated.	
21.15	Evacuated.	
21.25	Began to feed.	
21.29	Evacuated.	7.7 units of leaves taken.
21.40	Stopped to feed.	
22.07	Evacuated.	
22.26	Evacuated.	
22.48	Evacuated.	
23.10	Evacuated.	
23.35	Evacuated.	
23.51	Evacuated.	About 270 minutes.
24.37	Evacuated.	
24.57	Evacuated.	
24.59	Evacuated.	
1.15	Evacuated.	
1.30	Evacuated.	
1.48	Evacuated.	
2.10	Began to feed.	
2.15	Evacuated.	4.7 units of leaves taken.
2.20	Evacuated.	
2.28	Stopped to feed.	
2.54	Evacuated.	
3.19	Evacuated.	
3.40	Evacuated.	
3.50	Evacuated.	

4.05	Evacuated.	
4.20	Evacuated.	About 193 minutes.
4.45	Evacuated.	
5.05	Evacuated.	
5.20	Evacuated.	
5.40	Evacuated.	
6.00	Evacuated.	
6.05	Evacuated.	
6.07	Began to feed.	
6.20	Stopped to feed.	4.6 units of leaves taken.
6.50	Evacuated.	
7.20	Evacuated.	
8.15	Evacuated.	
8.45	Evacuated.	
9.08	Evacuated.	
9.22	Evacuated.	About 246 minutes
9.40	Evacuated.	
10.03	Evacuated.	
10.19	Evacuated.	
10.37	Evacuated.	
10.56	Evacuated.	
11.25	Evacuated.	
11.26	Began to feed.	
11.27	Evacuated.	5.4 units of leaves taken.
11.35	Stopped to feed.	
11.50	Evacuated.	
11.59	Evacuated.	
12.24	Evacuated.	
12.50	Evacuated.	
13.08	Evacuated.	About 205 minutes.
13.30	Evacuated.	
13.45	Evacuated.	
14.00	Observation ceased.	



Fig. 27. Leaves of a cherry tree eaten by
Phraortes kumamotoensis.



Fig. 28. *Phraortes kumamotoensis* resting on
the foliage of the wild rose tree, *Rosa
multiflora* Thunberg.

B. Material and Methods

In the present series of experiments on the food consumption of *Phraortes kumamotoensis* SHIRAKI, about seventy individuals were used, and three types of plants (three species of two different families) were used in rearing the material. The experiments were arranged in the following twelve classes.

Experiments Class 1: Ten newly hatched larvae (Nos. 1-10) were used and fed three times (8 o'clock, 13 o'clock, 17 o'clock) a day on the leaves of *Lyonia Neziki* NAKAI et HARA.

Experiments Class 2: Eight newly hatched larvae (Nos. 11-18) were used and fed three times (8 o'clock, 13 o'clock, 17 o'clock) a day on the leaves *Prunus subhirtella* MIQUEL.

Experiments Class 3: Five larvae in the last instar (Nos. 19-23) were used and fed three times every other day on the leaves of *Lyonia Neziki* NAKAI et HARA.

Experiments Class 4: Five larvae in the last instar (Nos. 24-28) were used and fed three times every third day on the leaves of *Lyonia Neziki* NAKAI et HARA.

Experiments Class 5: Five larvae in the last instar (Nos. 29-33) were used and fed three times (8 o'clock, 13 o'clock, 17 o'clock) a day on the leaves of *Amelanchier asiatica* ENDLICHER.

Experiments Class 6: Five larvae in the last instar (Nos. 34-38) were used and fed three times every fourth day on the leaves of *Lyonia Neziki* NAKAI et HARA.

Experiments Class 7: Five larvae in the last instar (Nos. 39-43) were used and fed once a day (8 o'clock) on the leaves of *Lyonia Neziki* NAKAI et HARA.

Experiments Class 8: Five larvae in the last instar (Nos. 44-48) were used and fed three times every other day on the leaves of *Lyonia Neziki* NAKAI et HARA.

Experiments Class 9: Five larvae in the last instar (Nos. 49-53) were used and fed once a day (8 o'clock) on the leaves of *Lyonia Neziki* NAKAI et HARA.

Experiments Class 10: Five larvae in the last instar (Nos. 54-58) were used and fed three times every third day on the leaves of *Lyonia Neziki* NAKAI et HARA.

Experiments Class 11: Five larvae in the last instar (Nos. 59-63)

were used and fed freely all the day on the leaves of *Lyonia Neziki* NAKAI et HARA.

Experiments Class 12: Five male larvae in the last instar (Nos. 64-68) were used and fed freely all the day on the leaves of *Lyonia Neziki* NAKAI et HARA.

In order to ascertain the amount of food consumed, outlines of the leaves were drawn before feeding by placing the leaves on a sheet of paper ruled in mm squares and running a pencil along their edges; these leaves were then put at the disposal of the insects. Immediately after one meal the leaves were fitted into their respective outlines on the sheets, and the portion missing, *i.e.* consumed, was outlined. The number of square mm in the missing portion was then counted, and recorded day by day until an expected time of the growth of insects.

On the other hand, the following physical properties of the leaves eaten partly by the insects were calculated every day in the course of the experiments.

1. The thickness.
2. The live weight *per* unit volume.
3. The dry weight *per* unit volume.
4. Water contents *per* unit volume.
5. Organic matter contents *per* unit volume.
6. Ash contents *per* unit volume.

The technique used for preparing leaves for this purpose is summarized as follows.

The leaves after being measured (the live weight and the thickness) were transferred into a sulphuric acid desiccator for about two days; taken out and weighed (the dry weight and water contents) on a Farady chemical balance sensitive to one-tenth of a milligram. Next the dry leaves were subjected to a temperature of about 150°C for one or two hours, then they were taken out and weighed (ash and organic matter contents) on the same balance. These operations were repeated as often as necessary till constant weights were obtained. Comparison of the respective outlined consumed portions in square mm could confirm the actual amount of the following items taken by each individual.

1. Amount of leaves eaten.
2. Amount of organic matter consumed.
3. Amount of water taken.

In all cases the observations were made on insects isolated from the first instar in rearing cage (one insect in each). The conditions created by life in cages would not actually affect the growth of the insects. Therefore, the measurements of food consumption of the insects in captivity do represent the data that would be obtained in nature. As it did not take a long time to begin to feed on the leaves when insects were put on the given diet by forceps, the feeding experiments were easily and safely carried out from the first instar to the adult.

C. Descriptions of the Results

The results of the present series of tests are summarized in sufficient details in Tables 50 to 159 as well as in Text-figures 29 to 49. In these tables the following abbreviations are used.

V: Volume of the leaf eaten *per* day by an insect (mm^3).

O: (Organic matter contents in mg in V) $\times 10^5$.

W: (Water contents in mg in V) $\times 10^5$.

ΣV : Volume of the leaf eaten by an insect in stadium n.

ΣO : Organic matter contents in ΣV .

ΣW : Water contents in ΣV .

$$F(\%): \frac{V_n}{V_1 + V_2 + \dots + V_n} \times 100$$

$$O': \frac{\Sigma O \text{ in stadium } n}{\text{Dry weight of exoskeleton of mesothorax of adult}^*}$$

$$W': \frac{\Sigma W \text{ in stadium } n}{\text{Dry weight of exoskeleton of mesothorax of adult}^*}$$

1. Experiments Series 1

Experiments Class 1

No. 1, ♀ No. 1 hatched out on April 25th and reached maturity on July 10th, its mesothorax in adult measured 17.0 mm

* mid-legs excluded.

in length. This insect completed six moults, the normal number necessary before attaining maturity (First moult on May 7th, second on May 21st, third on June 10th, fourth on June 21st, fifth on June 29th and sixth on July 10th). The length of the post-embryonic development was 77 days (First stadium 13 days, second 14 days, third 20 days, fourth 11 days, fifth 8 days and sixth 11 days). Thus it may be said that this insect underwent a normal growth. This insect was killed on July 20th for measurement of the dry weight of the exoskeleton of mesothorax. The dry weight was 0.008 gr.

No. 2 No. 2 hatched out on April 25th and died on May 11th during the first moulting. The volume of the leaves consumed by this insect in the first stadium was equivalent to that of the insect No. 1.

No. 3, ♂ No. 3 hatched out on April 24th and attained maturity on July 5th, its mesothorax in adult measured 17.5 mm in length. This insect underwent five moults before attaining maturity (First moult on May 13th, second on May 23rd, third on June 12th, fourth on June 24th and fifth on July 5th).

The time required for the post-embryonic growth was 73 days (First stadium 20 days, second 10 days, third 20 days, fourth 12 days and fifth 11 days). After a pre-oviposition period of ten days this insect was killed on July 15th for measuring the dry weight of the exoskeleton of mesothorax. The dry weight was 0.0105 gr.

No. 4, ♀ No. 4 hatched out on April 26th and reached maturity on July 12th, its mesothorax in adult measured 16.4 mm in length. The post-embryonic development of this insect proceeded six intervals between moults (First stadium 16 days, first moult on May 12th, second stadium 17 days, second moult on May 29th, third stadium 16 days, third moult on June 14th, fourth stadium 10 days, fourth moult on June 24th, fifth stadium 8 days, fifth moult on July 2nd, sixth stadium 11 days, sixth moult on July 12th). Thus the length of the post-embryonic development was 78 days. After ten days this insect was killed for measuring of the dry weight of the exoskeleton of the mesothorax. The dry weight was 0.0098 gr.

No. 5, ♂ This insect hatched out on April 24th and attained maturity on July 7th, its mesothorax in adult measured 17.0 mm in length. This insect moulted in the normal way five times

in completing its growth (First moult on May 11th, second on May 28th, third on June 16th, fourth on June 27th and fifth moult on July 7th).

The post-embryonic growth period lasted 73 days (First stadium 16 days, second 17 days, third 19 days, fourth 11 days and fifth 10 days). This insect was killed on July 16th for measuring the dry weight of the exoskeleton of mesothorax. The dry weight was 0.0120 gr.

No. 6, ♀ No. 6 hatched out on April 24th and reached maturity on July 9th, its mesothorax in adult measured 17.0 mm in length. During the period of the post-embryonic development it underwent six moults (First moult on May 10th, second on May 21st, third on June 10th, fourth on June 21st, fifth on June 28th and the last on July 9th). The length of the post-embryonic development was 76 days (First stadium 16 days, second 11 days, third 20 days, fourth 11 days, fifth 7 days and the last 11 days). This insect was killed on July 20th after a pre-oviposition period of nine days for measuring the dry weight of the exoskeleton of mesothorax. The dry weight was 0.0104 gr.

No. 7, ♂ This insect hatched out on April 24th and reached maturity on July 9th, its mesothorax measured 16.4 mm in length. The duration of the post-embryonic development lasted 76 days (First stadium 17 days, second 12 days, third 25 days, fourth 11 days and fifth 11 days). This insect underwent in the-normal manner five moults before attaining the adult stage (First moult on May 11th, second on May 23rd, third on June 16th, fourth on June 28th and fifth on July 9th). After attaining sexual maturity this insect was killed on July 20th for measuring the dry weight of the exoskeleton of mesothorax. The dry weight was 0.0048 gr.

No. 8, ♀ No. 8 hatched out on April 25th and attained maturity on July 14th, its mesothorax in adult measured 15.8 mm in length. The time necessary to pass through all stadia was 80 days (First instar 16 days, second 13 days, third 22 days, fourth 10 days, fifth 8 days and the final one 11 days). During the period of the post-embryonic growth it underwent six moults (First moult on May 11th, second on May 24th, third on June 15th, fourth on June 25th, fifth on July 3rd and the final on July 14th). This insect began to drop eggs on July 24th when it was

killed for measuring of the dry weight of the exoskeleton of mesothorax.⁹ The dry weight measured 0.0100 gr.

No. 9, ♂ No. 9 hatched out on April 24th and reached maturity on July 7th, its mesothorax in adult measured 14.2 mm in length. The length of each stadium is summarized as follows: first stadium 16 days, second 16 days, third 20 days, fourth 12 days and the last 10 days. Thus this insect underwent five moults during the post-embryonic growth period (First moult on May 11th, second on May 27th, third on June 16th, fourth on June 28th and the final on July 8th). This insect was killed on July 18th for measuring the dry weight of the exoskeleton of mesothorax. The dry weight gave the value 0.0117 gr.

No. 10, ♂ No. 10 hatched out on April 24th and underwent its first moult on May 12th. After 15 days the second moult took place, and the insect died on May 27th from an unknown cause.

Experiments Class 2

No. 11, ♂ No. 11 hatched out on April 26th and reached maturity on June 29th, its mesothorax in adult measured 16.2 mm in length. During the period of the post-embryonic growth it underwent five moults (First moult on May 10, second on May 22nd, third on June 2nd, fourth on June 12th and the final on July 29th). The length of the post-embryonic development was 66 days (First stadium 14 days, second 12 days, third 11 days, fourth 10 days and the last 17 days).

No. 12, ♂ This insect hatched out on May 1st and died on June 26th, five days after the fourth moult, when its mesothorax measured 16.0 mm in length. The first moult occurred on May 10th, the second on May 24th, the third on June 7th and the fourth on June 22nd respectively. The length of each stadium is summarized as follows: first stadium 9 days, second 18 days, third 10 days, fourth 15 days.

No. 13, ♂ No. 13 hatched out on April 26th and reached maturity on June 27th, its mesothorax in adult measured 17.0 mm in length. This insect moulted as normal five times before reaching the adult stage (First moult on May 11th, second on May

21st, third on June 1st, fourth on June 13th and fifth on June 27th). It took 62 days from the hatching to the emergence of the adult form (First stadium 15 days, second 10 days, third 11 days, fourth 12 days and the final 14 days). This insect was killed on July 5th for measuring the dry weight of the exoskeleton of mesothorax. The dry weight was 0.0140 gr.

No. 14, ♂ This insect hatched out on May 1st and attained maturity on June 30th, its mesothorax in adult measured 16.0 mm in length. The length of the larval growth period was 60 days (First stadium 13 days, second 11 days, third 10 days, fourth 13 days and the last 13 days). Thus the insect underwent five moults as normal during the larval period (First moult on May 13th, second on May 25th, third on June 4th, fourth on June 17th and the final on June 30th). This insect was killed on July 8th for measuring the dry weight of the exoskeleton of mesothorax. The dry weight was 0.0095 gr.

No. 15, ♂ No. 15 hatched out on April 26th and attained maturity on June 25th, its mesothorax in adult measured 16.8 mm in length. The length of the post-embryonic growth period was 60 days, taking the successive stadia as 13, 11, 10, 10 and 16 days respectively. The growth of this insect was normal and five moults took place during the larval stadia (First moult on May 9th, second on May 20th, third on May 30th, fourth on June 9th and the final on June 25th). This insect was killed on July 1st for measuring the dry weight of the exoskeleton of mesothorax. The dry weight measured 0.0090 gr.

No. 16, ♂ No. 16 hatched out on May 1st and matured on June 26th, its mesothorax in adult measured 17.0 mm in length. The duration of the post-embryonic development lasted 56 days (First stadium 11 days, second 9 days, third 10 days, fourth 12 days and fifth 14 days). During the larval stadia this insect moulted five times (First moult on May 12th, second on May 21st, third on May 31st, fourth on June 12th and the last on June 26th). This insect was killed on July 1st for measuring the dry weight of the exoskeleton of mesothorax. The dry weight was 0.0120 gr.

No. 17, ♀ No. 17 hatched out on April 26th and reached maturity on June 28th, its mesothorax measured 19.5 mm in length. The time necessary to pass through all larval stadia was 63 days

(First stadium 14 days, second 9 days, third 10 days, fourth 9 days, fifth 10 days and the final 11 days).

During the period of the post-embryonic development it underwent six moults (First moult on May 10th, second on May 10th, third on May 29th, fourth on June 7th, fifth on June 17th and the final on June 27th). After the pre-oviposition period of ten days, this insect was killed on July 7th for measuring the dry weight of the exoskeleton of mesothorax. The dry weight was 0.0245 gr. No. 18 No. 18 hatched out on April 29th, underwent two succeeding moults and died on June 2nd from an unknown cause. The first moult took place on May 13th and the second one occurred on May 29th. The first stadium lasted 15 days and the second one lasted 16 days.

Table 50. Amount of leaves eaten by *Phraortes kumamotoensis* during the larval stadia. No. 1.

Date	V	O	W	Date	V	O	W
25. iv.	1.5	10	12	3. vi.	27.0	186	248
26. iv.	6.2	43	57	4. vi.	51.0	352	469
27. iv.	5.8	40	53	5. vi.	55.2	381	508
28. iv.	8.2	57	75	6. vi.	55.0	380	506
29. iv.	25.0	173	230	7. vi.	20.0	138	184
30. iv.	16.0	110	147	8. vi.	50.0	345	460
1. v.	12.0	83	110	9. vi.	29.0	200	267
2. v.	16.0	110	147	10. vi.	0.0	0	0
3. v.	14.5	100	133	11. vi.	26.0	179	239
4. v.	11.0	76	101	12. vi.	54.0	373	497
5. v.	24.8	171	228	13. vi.	115.0	794	1058
6. v.	0.0	0	0	14. vi.	58.0	400	534
7. v.	0.0	0	0	15. vi.	152.0	1049	1398
8. v.	15.5	107	143	16. vi.	79.0	545	727
9. v.	22.0	152	202	17. vi.	79.0	545	727
10. v.	19.0	131	175	18. vi.	88.0	607	810
11. v.	23.0	159	212	19. vi.	107.0	738	984

12. v.	10.5	72	97	20. vi.	39.0	255	340
13. v.	16.0	110	147	21. vi.	0.0	0	0
14. v.	16.8	116	155	22. vi.	200.0	1380	1840
15. v.	28.7	198	264	23. vi.	114.0	787	1049
16. v.	38.0	262	350	24. vi.	424.0	2926	3901
17. v.	23.0	159	212	25. vi.	375.0	2588	3450
18. v.	97.0	669	892	26. vi.	513.0	3540	4720
19. v.	37.0	255	340	27. vi.	237.0	1635	2180
20. v.	20.0	138	184	28. vi.	11.0	76	101
21. v.	20.5	141	189	29. vi.	0.0	0	0
22. v.	11.0	76	101	30. vi.	215.0	1484	1978
23. v.	13.0	89	120	1. vii.	486.0	3353	4471
24. v.	13.7	95	126	2. vii.	124.0	856	1141
25. v.	25.8	178	237	3. vii.	777.0	5361	7148
26. v.	20.9	144	192	4. vii.	642.0	4430	5906
27. v.	13.8	95	127	5. vii.	676.0	4764	6219
28. v.	17.3	119	159	6. vii.	591.0	4078	5437
29. v.	20.4	141	188	7. vii.	488.5	3371	4493
30. v.	7.2	50	66	8. vii.	130.0	897	1196
31. v.	23.0	159	212	9. vii.	0.0	0	0
1. vi.	20.9	144	192	10. vii.	0.0	0	0
2. vi.	26.0	197	239				

Table 51. The same as above. No. 2.

Date	V	O	W	Date	V	O	W
25. iv.	1.9	13	17	4. v.	22.2	153	204
26. iv.	2.0	14	18	5. v.	22.2	153	204
27. iv.	7.0	48	64	6. v.	0.0	0	0
28. iv.	6.0	41	53	7. v.	1.2	8	11
29. iv.	11.0	76	101	8. v.	1.5	10	14
30. iv.	10.0	69	92	9. v.	20.0	138	184
1. v.	9.5	66	87	10. v.	7.3	50	67
2. v.	11.5	79	106	11. v.	0.0	0	0
3. v.	9.7	67	89				

Table 52. The same as above. No. 3.

Date	V	O	W	Date	V	O	W
24. iv.	2.0	14	18	1. vi.	28.5	197	262
25. iv.	2.2	15	20	2. vi.	24.7	170	227
26. iv.	1.8	12	17	3. vi.	27.0	186	248
27. iv.	5.6	39	52	4. vi.	21.0	145	193
28. iv.	7.9	55	73	5. vi.	50.6	349	466
29. iv.	9.0	62	83	6. vi.	50.0	345	460
30. iv.	10.0	69	92	7. vi.	51.0	352	469
1. v.	0.0	0	0	8. vi.	25.0	173	230
2. v.	8.0	55	74	9. vi.	53.9	372	496
3. v.	0.0	0	0	10. vi.	53.2	367	489
4. v.	13.5	93	124	11. vi.	39.0	269	359
5. v.	6.0	41	55	12. vi.	0.0	0	0
6. v.	19.3	133	178	13. vi.	0.0	0	0
7. v.	15.8	109	145	14. vi.	90.0	628	828
8. v.	23.7	164	218	15. vi.	60.7	419	568
9. v.	34.9	241	321	16. vi.	99.0	683	911
10. v.	24.2	167	223	17. vi.	42.0	290	386
11. v.	23.0	159	212	18. vi.	64.0	442	589
12. v.	26.0	179	239	19. vi.	168.0	1159	1546
13. v.	0.0	0	0	20. vi.	120.0	828	1104
14. v.	0.0	0	0	21. vi.	163.6	1129	1505
15. v.	0.0	0	0	22. vi.	136.6	943	1257
16. v.	49.0	338	451	23. vi.	174.0	1201	1601
17. v.	0.0	0	0	24. vi.	0.0	0	0
18. v.	94.0	649	865	25. vi.	25.0	173	230
19. v.	74.5	514	685	26. vi.	289.0	1994	2659
20. v.	100.6	694	926	27. vi.	303.5	2094	2792
21. v.	26.0	179	239	28. vi.	265.0	1829	2438
22. v.	15.1	104	139	29. vi.	320.7	2213	2950
23. v.	0.0	0	0	30. vi.	311.0	2056	2861
24. v.	0.0	0	0	1. vii.	397.0	2739	3652
25. v.	29.3	202	270	2. vii.	290.0	2001	2668
26. v.	30.8	213	283	3. vii.	293.5	2025	2700
27. v.	26.3	181	242	4. vii.	0.0	0	0
28. v.	20.0	138	184	5. vii.	0.0	0	0
29. v.	11.8	81	109				
30. v.	47.2	326	434				
31. v.	16.0	110	147				

Table 53. The same as above. No. 4.

Date	V	O	W	Date	V	O	W
26. iv.	2.6	18	24	4. vi.	16.0	110	147
27. iv.	2.3	16	21	5. vi.	27.9	193	257
28. iv.	3.8	26	35	6. vi.	23.2	160	213
29. iv.	7.3	50	67	7. vi.	34.5	238	317
30. iv.	13.7	95	126	8. vi.	46.3	319	426
1. v.	0.0	0	0	9. vi.	43.8	302	403
2. v.	3.1	21	29	10. vi.	75.2	519	692
3. v.	10.2	70	94	11. vi.	38.0	262	350
4. v.	12.2	84	112	12. vi.	47.0	324	432
5. v.	0.0	0	0	13. vi.	0.0	0	0
6. v.	17.5	121	161	14. vi.	11.0	76	101
7. v.	31.5	217	290	15. vi.	49.8	344	458
8. v.	25.5	176	235	16. vi.	72.0	497	662
9. v.	37.2	257	342	17. vi.	62.0	428	570
10. v.	30.9	213	284	18. vi.	122.0	842	1122
11. v.	0.0	0	0	19. vi.	163.0	1123	1500
12. v.	0.0	0	0	20. vi.	162.0	1118	1490
13. v.	0.0	0	0	21. vi.	202.0	1394	1858
14. v.	0.0	0	0	22. vi.	84.0	580	773
15. v.	23.0	159	212	23. vi.	0.0	0	0
16. v.	13.8	95	127	24. vi.	0.0	0	0
17. v.	11.5	79	106	25. vi.	215.0	1484	1978
18. v.	78.8	544	725	26. vi.	399.0	2753	3671
19. v.	39.0	269	359	27. vi.	361.6	2395	2327
20. v.	5.2	36	48	28. vi.	502.8	3469	4626
21. v.	6.2	43	57	29. vi.	293.0	2022	2696
22. v.	31.6	218	291	30. vi.	272.0	1877	2502
23. v.	16.0	110	147	1. vii.	0.0	0	0
24. v.	32.5	224	299	2. vii.	6.0	414	552
25. v.	42.6	294	392	3. vii.	297.0	2049	2732
26. v.	6.3	43	58	4. vii.	288.0	1987	2650
27. v.	13.0	90	120	5. vii.	601.0	4147	5529
28. v.	7.0	48	64	6. vii.	515.5	3557	4743
29. v.	3.2	22	29	7. vii.	765.0	5279	7038
30. v.	17.8	123	164	8. vii.	253.0	1746	2328
31. v.	23.2	160	213	9. vii.	406.0	2801	3735
1. vi.	19.9	137	183	10. vii.	150.0	1035	1380
2. vi.	28.8	199	265	11. vii.	0.0	0	0
3. vi.	23.3	161	214	12. vii.	0.0	0	0

Table 54. The same as above. No. 5.

Date	V	O	W	Date	V	O	W
24. iv.	0.2	1	2	31. v.	27.9	193	257
25. iv.	0.3	2	3	1. vi.	14.4	99	132
26. iv.	1.4	10	13	2. vi.	28.9	199	266
27. iv.	2.0	14	18	3. vi.	20.8	144	191
28. iv.	13.0	90	120	4. vi.	25.5	176	235
29. iv.	16.0	110	147	5. vi.	44.7	208	411
30. iv.	11.1	77	102	6. vi.	54.2	374	499
1. v.	12.0	83	110	7. vi.	44.6	308	410
2. v.	0.0	0	0	8. vi.	41.4	286	381
3. v.	16.5	114	152	9. vi.	11.3	77	104
4. v.	14.3	99	132	10. vi.	10.8	75	99
5. v.	15.4	106	142	11. vi.	70.0	483	644
6. v.	25.0	173	230	12. vi.	55.0	380	506
7. v.	26.8	185	247	13. vi.	5.5	38	51
8. v.	0.0	0	0	14. vi.	32.9	227	303
9. v.	0.0	0	0	15. vi.	0.0	0	0
10. v.	0.0	0	0	16. vi.	4.2	29	37
11. v.	11.0	76	101	17. vi.	51.0	352	469
12. v.	0.0	0	0	18. vi.	75.3	520	693
13. v.	8.4	58	77	19. vi.	80.0	552	736
14. v.	0.0	0	0	20. vi.	58.4	403	537
15. v.	20.8	144	191	21. vi.	90.3	623	831
16. v.	53.9	372	496	22. vi.	146.8	1013	1351
17. v.	49.0	338	451	23. vi.	168.0	1159	1546
18. v.	23.2	160	213	24. vi.	199.3	1375	1834
19. v.	38.0	262	350	25. vi.	90.3	623	831
20. v.	17.0	117	156	26. vi.	0.0	0	0
21. v.	28.7	198	264	27. vi.	140.1	967	1289
22. v.	25.0	173	230	28. vi.	430.7	2972	3962
23. v.	16.2	112	149	29. vi.	211.0	1556	1941
24. v.	16.5	114	152	30. vi.	407.8	2814	3752
25. v.	13.7	95	126	1. vii.	270.0	1863	2484
26. v.	0.0	0	0	2. vii.	360.6	2488	3316
27. v.	0.0	0	0	3. vii.	333.0	2298	3064
28. v.	12.7	88	117	4. vii.	120.0	8280	11040
29. v.	22.7	157	207	5. vii.	0.0	0	0
30. v.	26.0	179	239	6. vii.	0.0	0	0

Table 55. The same as above. No. 6.

Date	V	O	W	Date	V	O	W
24. iv.	1.2	8	11	2. vi.	32.5	224	299
25. iv.	1.8	12	17	3. vi.	53.0	366	488
26. iv.	1.7	12	16	4. vi.	66.0	455	607
27. iv.	14.0	97	129	5. vi.	49.0	338	451
28. iv.	11.0	76	101	6. vi.	87.0	600	800
29. iv.	14.7	101	135	7. vi.	25.0	173	230
30. iv.	8.0	55	74	8. vi.	40.0	276	368
1. v.	5.0	35	46	9. vi.	0.0	0	0
2. v.	11.5	79	106	10. vi.	0.0	0	0
3. v.	6.2	43	57	11. vi.	27.0	186	248
4. v.	14.9	103	137	12. vi.	37.0	255	340
5. v.	21.8	150	201	13. vi.	128.0	883	1178
6. v.	5.3	37	49	14. vi.	82.8	571	762
7. v.	28.4	196	261	15. vi.	206.0	1421	1895
8. v.	26.8	185	247	16. vi.	79.8	451	734
9. v.	0.0	0	0	17. vi.	134.5	928	1237
10. v.	4.2	29	39	18. vi.	170.5	1176	1569
11. v.	22.5	155	207	19. vi.	118.5	818	1090
12. v.	10.3	71	95	20. vi.	0.0	0	0
13. v.	3.0	21	28	21. vi.	6.3	43	58
14. v.	46.6	322	429	22. vi.	254.5	1756	2341
15. v.	2.8	19	26	23. vi.	230.0	1587	2116
16. v.	63.9	441	588	24. vi.	400.3	2762	3683
17. v.	76.4	527	703	25. vi.	415.0	2864	3818
18. v.	70.0	483	644	26. vi.	420.7	2903	3870
19. v.	7.0	48	64	27. vi.	292.5	2018	2691
20. v.	0.0	0	0	28. vi.	0.0	0	0
21. v.	0.0	0	0	29. vi.	175.5	1211	1615
22. v.	4.9	34	45	30. vi.	706.2	4873	6497
23. v.	18.5	128	170	1. vii.	721.6	4979	6639
24. v.	17.5	121	161	2. vii.	581.8	4014	5353
25. v.	23.0	159	212	3. vii.	671.2	4631	6175
26. v.	27.8	192	256	4. vii.	850.0	5865	7820
27. v.	26.4	182	243	5. vii.	724.4	4998	6664
28. v.	10.0	69	92	5. vii.	492.5	3398	4531
29. v.	34.1	235	314	7. vii.	103.5	714	952
30. v.	12.2	84	112	8. vii.	0.0	0	0
31. v.	36.5	252	336	9. vii.	0.0	0	0
1. vi.	29.0	200	267				

Table 56. The same as above. No. 7.

Date	V	O	W	Date	V	O	W
24. iv.	1.9	13	17	2. vi.	15.2	105	140
25. vi.	2.4	17	22	3. vi.	13.7	95	126
26. vi.	2.3	16	21	4. vi.	20.8	143	191
27. vi.	10.7	74	98	5. vi.	10.2	70	94
28. vi.	10.1	70	93	6. vi.	35.0	242	322
29. vi.	14.8	102	136	7. vi.	34.3	237	316
30. vi.	7.3	50	67	8. vi.	29.0	200	267
1. v.	20.2	139	186	9. vi.	55.2	381	508
2. v.	8.3	57	76	10. vi.	58.0	400	534
3. v.	28.0	193	258	11. vi.	70.6	487	650
4. v.	13.0	90	120	12. vi.	38.3	264	352
5. v.	11.8	81	109	13. vi.	90.5	624	833
6. v.	35.0	242	322	14. vi.	76.1	525	700
7. v.	35.9	248	330	15. vi.	34.0	235	313
8. v.	32.0	221	294	16. vi.	0.0	0	0
9. v.	0.0	0	0	17. vi.	7.1	49	65
10. v.	0.0	0	0	18. vi.	46.3	319	426
11. v.	4.2	29	37	19. vi.	91.5	631	842
12. v.	24.2	167	223	20. vi.	167.0	1152	1536
13. v.	26.0	179	239	21. vi.	130.0	897	1196
14. v.	35.5	245	327	22. vi.	91.0	628	837
15. v.	79.0	545	727	23. vi.	169.0	1166	1555
16. v.	31.9	220	293	24. vi.	170.0	1173	1564
17. v.	67.3	464	619	25. vi.	183.5	1266	1688
18. v.	83.8	578	771	26. vi.	83.0	573	764
19. v.	25.0	172	230	27. vi.	0.0	0	0
20. v.	0.0	0	0	28. vi.	0.0	0	0
21. v.	0.0	0	0	29. vi.	127.2	878	1170
22. v.	80.5	555	741	30. vi.	334.8	2310	3080
23. v.	11.0	76	101	1. vii.	274.5	1894	2526
24. v.	0.0	0	0	2. vii.	331.3	2286	3048
25. v.	0.0	0	0	3. vii.	271.5	1873	2498
26. v.	13.3	92	122	4. vii.	388.5	2681	3574
27. v.	21.0	145	193	5. vii.	263.5	1818	2424
28. v.	11.9	82	109	6. vii.	95.5	559	879
29. v.	19.0	131	175	7. vii.	203.0	1401	1868
30. v.	30.4	210	280	8. vii.	0.0	0	0
31. v.	8.6	59	79	9. vii.	0.0	0	0
1. vi.	19.7	136	181				

Table 57. The same as above. No. 8.

Date	V	O	W	Date	V	O	W
25. iv.	0.0	0	0	5. vi.	29.0	200	267
26. iv.	2.0	14	18	6. vi.	61.7	426	568
27. iv.	2.5	17	23	7. vi.	53.0	366	488
28. iv.	5.0	35	46	8. vi.	43.5	300	400
29. iv.	7.0	48	64	9. vi.	71.0	490	653
30. iv.	17.0	117	156	10. vi.	1.0	7	9
1. v.	15.9	110	145	11. vi.	24.3	168	224
2. v.	10.6	73	98	12. vi.	63.8	440	587
3. v.	1.8	12	17	13. vi.	27.0	206	248
4. v.	27.3	188	251	14. vi.	0.0	0	0
5. v.	0.0	0	0	15. vi.	0.0	0	0
6. v.	23.8	164	219	16. vi.	46.7	320	410
7. v.	8.0	55	74	17. vi.	77.5	535	713
8. v.	32.0	221	294	18. vi.	36.0	248	331
9. v.	18.8	130	173	19. vi.	184.5	1273	1697
10. v.	0.0	0	0	20. vi.	82.8	571	762
11. v.	0.0	0	0	21. vi.	125.0	863	1150
12. v.	15.8	109	145	22. vi.	130.0	897	1196
13. v.	26.5	183	245	23. vi.	120.8	836	1111
14. v.	3.8	26	35	24. vi.	167.0	1152	1536
15. v.	62.9	434	579	25. vi.	0.0	0	0
16. v.	20.5	141	189	26. vi.	21.3	147	196
17. v.	0.0	0	0	27. vi.	229.0	1580	2107
18. v.	77.2	533	710	28. vi.	182.3	1258	1677
19. v.	44.1	304	406	29. vi.	408.5	2819	3758
20. v.	149.7	1033	1377	30. vi.	286.8	1979	2639
21. v.	54.3	375	500	1. vii.	466.5	3219	4292
22. v.	0.0	0	0	2. vii.	167.0	1152	1536
23. v.	0.0	0	0	3. vii.	0.0	0	0
24. v.	0.0	0	0	4. vii.	91.8	633	845
25. v.	11.2	77	103	5. vii.	379.5	2619	3491
26. v.	24.5	169	225	6. vii.	766.5	5289	7052
27. v.	9.9	68	91	7. vii.	496.5	3426	4568
28. v.	17.6	121	162	8. vii.	576.0	3974	5299
29. v.	15.7	108	144	9. vii.	484.3	3342	4456
30. v.	26.0	179	239	10. vii.	419.8	2897	3862
31. v.	11.9	82	109	11. vii.	455.3	3142	4189
1. vi.	21.6	149	199	12. vii.	270.0	1863	2484
2. vi.	10.0	69	92	13. vii.	0.0	0	0
3. vi.	22.4	155	206	14. vii.	0.0	0	0
4. vi.	28.8	199	265				

Table 58. The same as above. No. 9.

Date	V	O	W	Date	V	O	W
24. iv.	1.8	12	17	1. vi.	33.0	228	304
25. iv.	1.6	11	15	2. vi.	6.0	41	55
26. iv.	1.7	12	16	3. vi.	18.1	125	167
27. iv.	4.8	33	44	4. vi.	18.3	126	168
28. iv.	8.5	53	78	5. vi.	21.3	147	196
29. iv.	6.6	46	61	6. vi.	36.0	248	331
30. iv.	14.0	97	129	7. vi.	40.0	276	368
1. v.	12.5	86	115	8. vi.	37.0	255	340
2. v.	11.6	80	107	9. vi.	53.0	366	488
3. v.	7.5	52	69	10. vi.	28.0	193	258
4. v.	0.0	0	0	11. vi.	50.0	345	460
5. v.	24.6	170	226	12. vi.	43.0	297	396
6. v.	13.0	90	120	13. vi.	44.8	309	412
7. v.	29.0	200	267	14. vi.	5.2	36	48
8. v.	3.8	26	35	15. vi.	0.0	0	0
9. v.	0.0	0	0	16. vi.	13.0	90	120
10. v.	0.0	0	0	17. vi.	43.3	299	399
11. v.	10.0	69	92	18. vi.	0.0	0	0
12. v.	20.6	142	190	19. vi.	70.6	487	650
13. v.	5.8	40	53	20. vi.	40.0	276	368
14. v.	17.0	117	156	21. vi.	125.0	863	1150
15. v.	0.0	0	0	22. vi.	81.2	560	747
16. v.	14.7	101	135	23. vi.	143.0	987	1316
17. v.	12.8	88	118	24. vi.	77.0	531	708
18. v.	68.5	473	630	25. vi.	203.0	1401	1868
19. v.	63.8	440	587	26. vi.	51.5	355	474
20. v.	44.3	306	408	27. vi.	0.0	0	0
21. v.	62.0	428	570	28. vi.	314.5	2170	2893
22. v.	1.2	8	11	29. vi.	192.0	1325	1766
23. v.	0.0	0	0	30. vi.	261.3	1803	2404
24. v.	6.3	43	58	1. vii.	237.2	1637	2182
25. v.	0.0	0	0	2. vii.	148.5	1025	1366
26. v.	0.0	0	0	3. vii.	293.7	2027	2702
27. v.	16.0	110	147	4. vii.	361.1	2492	3322
28. v.	25.4	175	234	5. vii.	257.8	1779	2372
29. v.	26.1	180	240	6. vii.	80.2	553	738
30. v.	34.6	239	318	7. vii.	0.0	0	0
31. v.	3.5	24	32				

Table 59. The same as above. No. 10.

Date	V	O	W	Date	V	O	W
24. iv.	0.5	3	5	11. v.	0.0	0	0
25. iv.	1.0	7	9	12. v.	0.0	0	0
26. iv.	2.5	17	22	13. v.	7.0	48	64
27. iv.	3.0	21	28	14. v.	10.3	71	95
28. iv.	3.2	22	29	15. v.	20.0	138	184
29. iv.	8.0	55	74	16. v.	28.0	193	258
30. iv.	12.0	73	110	17. v.	6.8	47	63
1. v.	13.8	95	127	18. v.	27.7	191	255
2. v.	11.0	76	101	19. v.	48.4	334	445
3. v.	0.0	0	0	20. v.	49.3	340	454
4. v.	18.9	130	174	21. v.	4.0	28	37
5. v.	14.8	102	136	22. v.	15.4	106	142
6. v.	19.0	131	175	23. v.	4.2	29	39
7. v.	11.9	82	109	24. v.	6.3	43	58
8. v.	17.9	119	159	25. v.	11.7	81	108
9. v.	21.1	146	194	26. v.	7.2	50	62
10. v.	3.0	21	28				

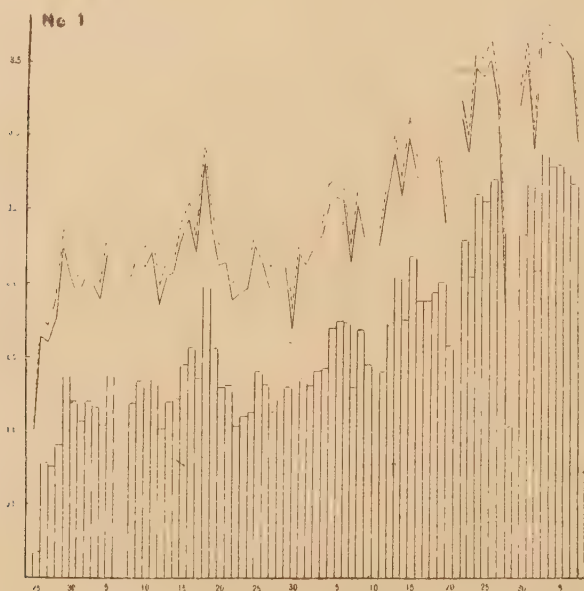
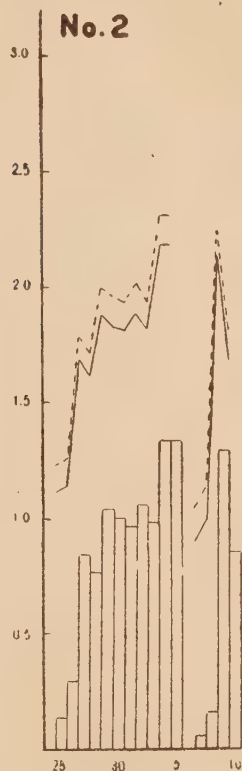
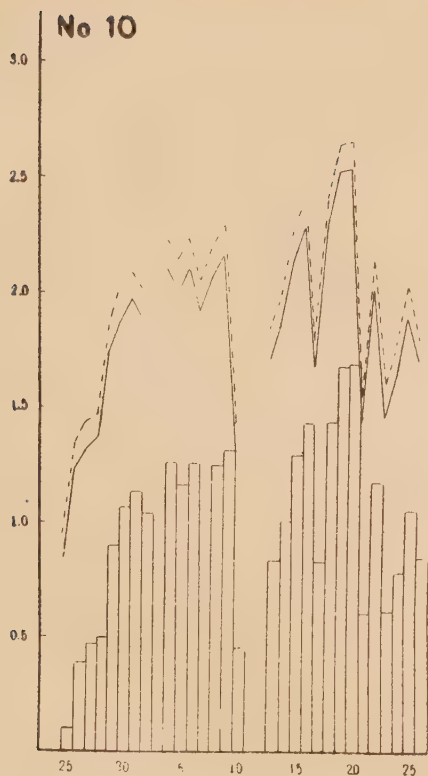
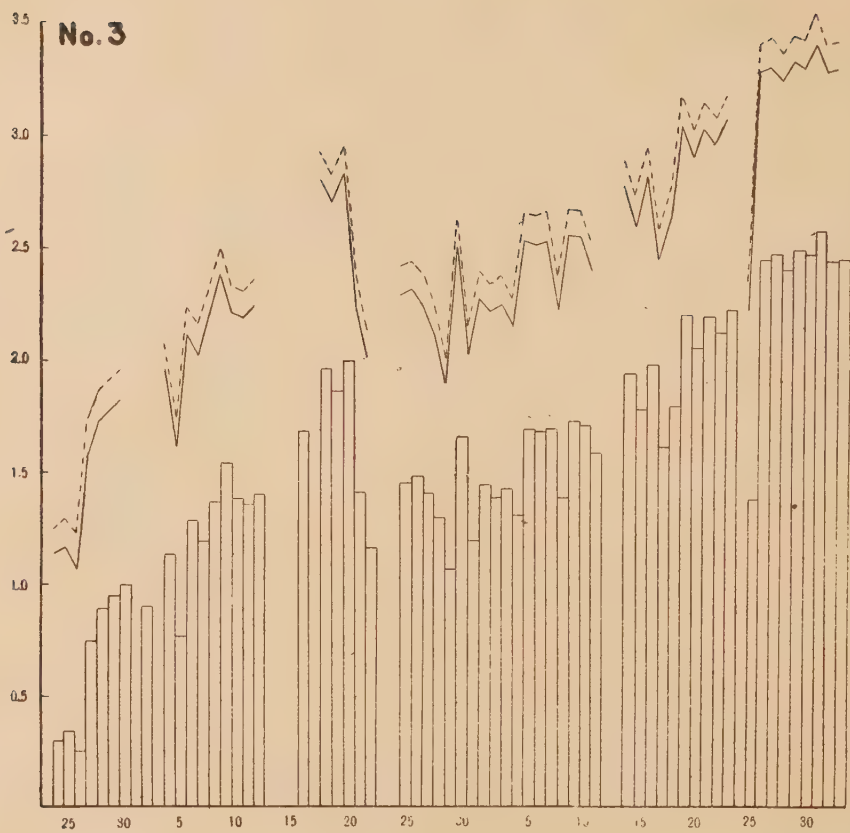
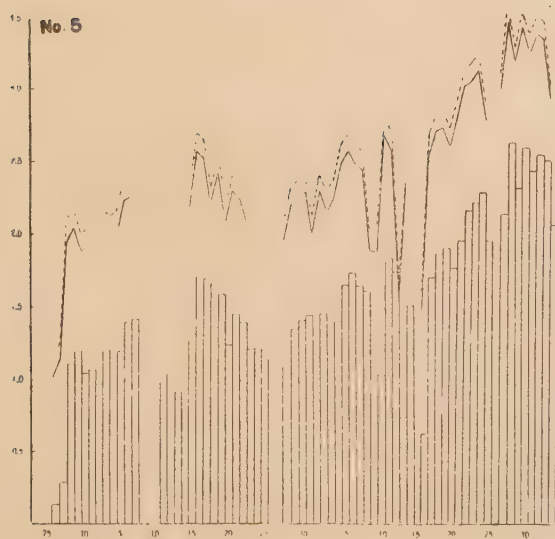
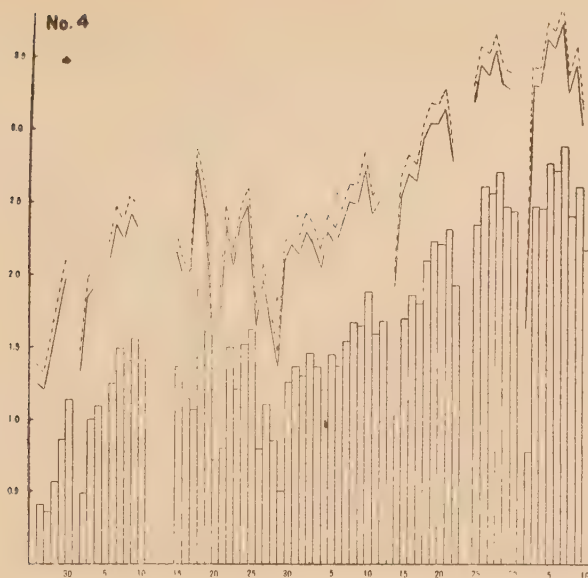
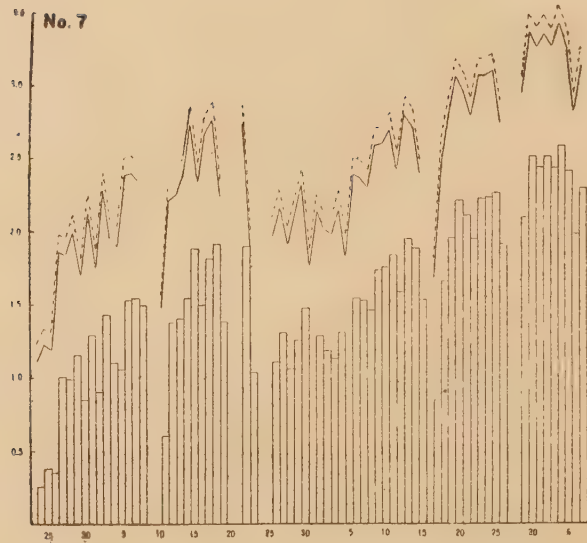
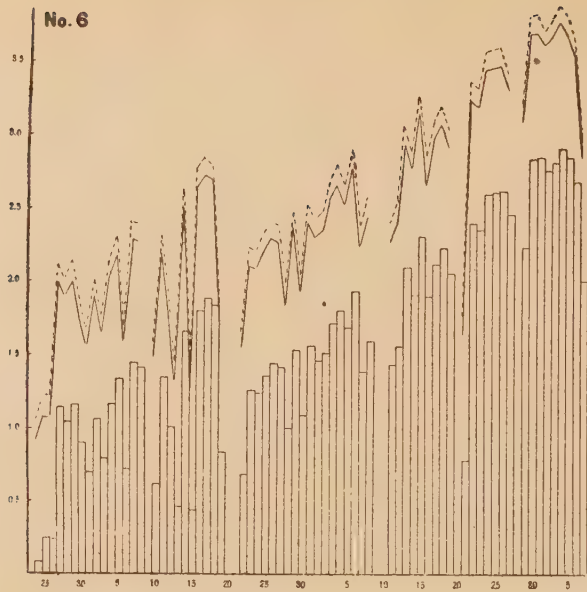


Fig. 29. Amount of leaves eaten by *Phraortes kumamotoensis* during the larval stadia. Abscissa represents time in date from April to July. Ordinate represents the logarithms of the measured values. Broken line indicates log W. Full line indicates log O. Square represenis log V.









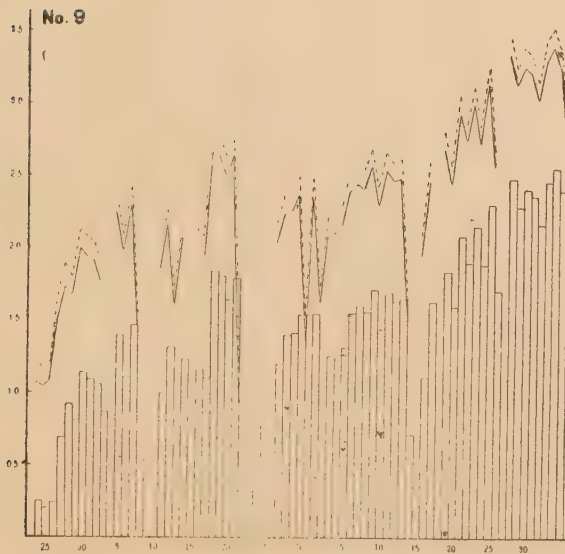
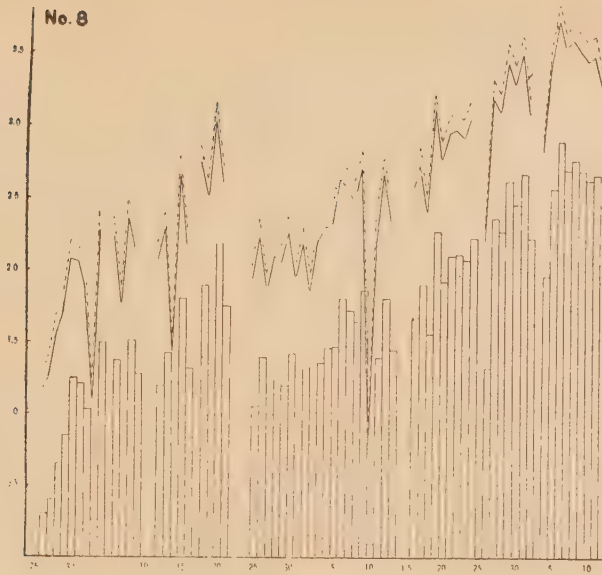


Table 60. Amount of leaves eaten by *Phraortes kumamotoensis* during the larval stadia. No. 11.

Date	V	O	W	Date	V	O	W
26. iv.	4.3	31	49	27. v.	61.5	437	707
27. iv.	4.0	28	46	28. v.	80.0	568	920
28. iv.	4.0	28	46	29. v.	75.0	523	863
29. iv.	5.0	36	58	30. v.	121.0	859	1392
30. iv.	3.5	35	40	31. v.	101.0	717	1162
1. v.	8.0	57	92	1. vi.	13.0	92	150
2. v.	3.8	27	44	2. vi.	0.0	0	0
3. v.	8.7	62	100	3. vi.	61.5	437	707
4. v.	4.0	28	46	4. vi.	125.5	891	1443
5. v.	11.8	84	136	5. vi.	128.0	909	1472
6. v.	7.4	53	85	6. vi.	122.0	866	1403
7. v.	13.9	99	160	7. vi.	184.5	1310	2122
8. v.	15.3	109	176	8. vi.	131.0	930	1507
9. v.	20.1	143	231	9. vi.	179.0	1271	2059
10. v.	0.0	0	0	10. vi.	137.0	973	1575
11. v.	6.2	44	71	11. vi.	87.0	618	1001
12. v.	0.0	0	0	12. vi.	58.0	412	667
13. v.	20.0	142	230	13. vi.	346.0	2457	3979
14. v.	23.5	167	270	14. vi.	138.0	980	1587
15. v.	37.0	263	426	15. vi.	309.0	2194	3554
16. v.	36.5	259	420	16. vi.	198.0	1405	2277
17. v.	41.5	295	477	17. vi.	211.0	1498	2427
18. v.	31.0	220	357	18. vi.	162.0	1150	1863
19. v.	24.0	170	276	19. vi.	236.0	1676	2714
20. v.	38.0	270	437	20. vi.	246.0	1747	2829
21. v.	0.0	0	0	21. vi.	165.0	1172	1898
22. v.	0.0	0	0	22. vi.	198.0	1406	2277
23. v.	2.0	14	23	23. vi.	175.0	1243	2013
24. v.	44.0	312	506	24. vi.	158.5	1125	1823
25. v.	67.5	479	776	25. vi.	223.0	1583	2565
26. v.	60.0	426	690	26. vi.	38.0	270	437
				27. vi.	0.0	0	0

Table 61. The same as above. No. 12.

Date	V	O	W	Date	V	O	W
1. v.	0.0	0	0	30. v.	136.6	970	1571
2. v.	0.0	0	0	31. v.	218.9	1554	2517
3. v.	9.4	66	108	1. vi.	95.5	678	1098
4. v.	5.5	39	63	2. vi.	165.3	1174	1901
5. v.	8.5	60	98	3. vi.	171.3	1216	1970
6. v.	16.7	119	192	4. vi.	126.6	899	1456
7. v.	17.0	121	196	5. vi.	380.4	2701	4375
8. v.	26.2	186	301	6. vi.	31.5	224	362
9. v.	0.0	0	0	7. vi.	0.0	0	0
10. v.	0.0	0	0	8. vi.	88.3	627	1015
11. v.	26.3	187	302	9. vi.	228.3	1621	2625
12. v.	20.5	146	236	10. vi.	219.9	1561	2529
13. v.	28.7	204	330	11. vi.	197.5	1402	2271
14. v.	39.5	280	454	12. vi.	225.0	1598	2588
15. v.	51.6	366	593	13. vi.	200.0	1420	2300
16. v.	40.5	288	466	14. vi.	110.1	782	1266
17. v.	50.7	360	583	15. vi.	239.7	1702	2757
18. v.	29.0	206	334	16. vi.	258.4	1835	2972
19. v.	68.5	486	788	17. vi.	187.8	1333	2160
20. v.	40.0	284	460	18. vi.	50.8	361	584
21. v.	72.9	518	838	19. vi.	122.4	869	1408
22. v.	87.1	618	1002	20. vi.	55.0	391	633
23. v.	73.3	520	843	21. vi.	0.0	0	0
24. v.	108.5	770	1248	22. vi.	0.0	0	0
25. v.	81.9	581	942	23. vi.	258.3	1834	2970
26. v.	69.9	496	804	24. vi.	265.5	1885	3053
27. v.	23.1	164	266	25. vi.	241.6	1715	2778
28. v.	0.0	0	0	26. vi.			
29. v.	77.3	552	893				

Table 62. The same as above. No. 13.

Date	V	O	W	Date	V	O	W
26. iv.	1.2	9	14	28. v.	45.3	322	521
27. iv.	2.5	18	29	29. v.	43.0	305	495
28. iv.	3.0	21	35	30. v.	50.0	355	575
29. iv.	6.0	43	69	31. v.	0.0	0	0
30. iv.	14.4	102	166	1. vi.	0.0	0	0
1. v.	5.2	38	61	2. vi.	54.5	387	627
2. v.	5.0	36	58	3. vi.	91.8	652	1056
3. v.	9.0	64	104	4. vi.	76.8	545	883
4. v.	7.0	50	81	5. vi.	144.8	1028	1665
5. v.	10.0	71	115	6. vi.	116.4	826	1339
6. v.	8.7	62	100	7. vi.	149.2	1059	1716
7. v.	18.4	131	212	8. vi.	109.0	774	1254
8. v.	15.4	109	177	9. vi.	146.7	1042	1687
9. v.	20.7	147	238	10. vi.	77.0	547	886
10. v.	0.0	0	0	11. vi.	122.1	867	1404
11. v.	0.0	0	0	12. vi.	0.0	0	0
12. v.	24.0	192	276	13. vi.	0.0	0	0
13. v.	18.1	129	208	14. vi.	148.0	1051	1702
14. v.	30.3	215	348	15. vi.	156.8	1113	1797
15. v.	33.5	238	385	16. vi.	189.3	1344	2177
16. v.	37.2	264	428	17. vi.	125.4	890	1442
17. v.	45.1	320	519	18. vi.	231.2	1642	2659
18. v.	47.3	336	544	19. vi.	268.6	1907	3089
19. v.	76.7	545	882	20. vi.	149.4	1061	1718
20. v.	0.0	0	0	21. vi.	135.8	964	1562
21. v.	0.0	0	0	22. vi.	150.0	1065	1725
22. v.	51.2	364	589	23. vi.	153.7	963	1561
23. v.	42.3	300	486	24. vi.	172.8	1227	1987
24. v.	49.3	350	567	25. vi.	64.3	457	739
25. v.	65.8	467	757	26. vi.	0.0	0	0
26. v.	105.2	747	1210	27. vi.	0.0	0	0
27. v.	63.0	447	725				

Table 63. The same as above. No. 14.

Date	V	O	W	Date	V	O	W
1. v.	0.0	0	0	31. v.	81.2	577	934
2. v.	0.0	0	0	1. vi.	90.4	643	1040
3. v.	7.0	50	81	2. vi.	69.2	491	796
4. v.	5.7	40	66	3. vi.	26.0	185	299
5. v.	7.5	53	86	4. vi.	0.0	0	0
6. v.	9.9	70	114	5. vi.	68.2	484	784
7. v.	12.6	89	145	6. vi.	68.9	489	792
8. v.	9.6	68	110	7. vi.	116.2	825	1336
9. v.	16.5	117	190	8. vi.	68.3	485	785
10. v.	31.0	220	357	9. vi.	134.0	951	1541
11. v.	14.5	103	167	10. vi.	149.0	1064	1724
12. v.	4.8	34	55	11. vi.	146.8	1042	1688
13. v.	0.0	0	0	12. vi.	153.2	1088	1762
14. v.	0.0	0	0	13. vi.	175.8	1248	2022
15. v.	25.0	178	288	14. vi.	128.2	910	1474
16. v.	31.8	226	366	15. vi.	0.0	0	0
17. v.	28.3	201	325	16. vi.	0.0	0	0
18. v.	49.1	349	565	17. vi.	0.0	0	0
19. v.	18.9	131	217	18. vi.	156.6	1112	1801
20. v.	43.1	306	496	19. vi.	246.2	1748	2831
21. v.	47.3	336	544	20. vi.	202.0	1434	2323
22. v.	24.5	174	282	21. vi.	229.5	1629	2639
23. v.	25.0	178	288	22. vi.	188.8	1340	2171
24. v.	0.0	0	0	23. vi.	231.0	1640	2657
25. v.	0.0	0	0	24. vi.	231.9	1646	2667
26. v.	42.1	299	484	25. vi.	210.0	1491	2415
27. v.	51.4	365	591	26. vi.	201.5	1431	2318
28. v.	54.0	383	621	27. vi.	154.0	1093	1771
29. v.	77.7	552	894	28. vi.	48.5	344	558
30. v.	101.5	721	1167	29. vi.	0.0	0	0

Table 64. The same as above. No. 15.

Date	V	O	W	Date	V	O	W
26. iv.	2.2	16	25	27. v.	63.5	451	730
27. iv.	4.0	28	46	28. v.	52.0	369	598
28. iv.	6.0	43	69	29. v.	32.7	232	376
29. iv.	7.2	51	83	30. v.	0.0	0	0
30. iv.	9.0	64	104	31. v.	86.9	617	999
1. v.	9.0	64	104	1. vi.	130.1	924	1496
2. v.	6.2	42	73	2. vi.	118.5	841	1363
3. v.	16.0	114	184	3. vi.	98.9	702	1137
4. v.	9.0	64	104	4. vi.	155.3	1103	1786
5. v.	15.3	109	176	5. vi.	176.8	1255	2033
6. v.	11.1	79	128	6. vi.	103.9	738	1195
7. v.	17.2	122	198	7. vi.	126.7	900	1457
8. v.	16.0	114	184	8. vi.	54.3	386	624
9. v.	0.0	0	0	9. vi.	0.0	0	0
10. v.	18.6	132	214	10. vi.	80.6	572	927
11. v.	41.1	292	473	11. vi.	159.5	1132	1834
12. v.	31.0	220	357	12. vi.	234.1	1662	2692
13. v.	25.0	178	288	13. vi.	223.5	1587	2570
14. v.	45.0	320	518	14. vi.	267.5	1899	3076
15. v.	51.5	366	592	15. vi.	41.8	297	481
16. v.	20.0	142	230	16. vi.	238.5	1693	2743
17. v.	44.7	217	514	17. vi.	180.0	1278	2070
18. v.	17.0	121	196	18. vi.	153.5	1090	1765
19. v.	0.0	0	0	19. vi.	162.0	1150	1863
20. v.	0.0	0	0	20. vi.	157.0	1115	1806
21. v.	34.2	243	393	21. vi.	170.0	1207	1955
22. v.	67.0	476	771	22. vi.	118.3	840	1360
23. v.	107.0	760	1231	23. vi.	0.0	0	0
24. v.	74.8	531	860	24. vi.	0.0	0	0
25. v.	80.0	568	920	25. vi.	0.0	0	0
26. v.	90.5	643	1041				

Table 65. The same as above. No. 16.

Date	V	O	W	Date	V	O	W
1. v.	0.0	0	0	30. v.	31.8	226	366
2. v.	3.4	24	39	31. v.	0.0	0	0
3. v.	6.6	47	76	1. vi.	46.5	330	535
4. v.	4.2	30	48	2. vi.	103.0	731	1185
5. v.	6.3	45	72	3. vi.	73.7	523	848
6. v.	6.1	43	70	4. vi.	116.7	829	1342
7. v.	6.7	48	77	5. vi.	107.5	763	1236
8. v.	7.2	51	83	6. vi.	92.7	658	1066
9. v.	4.4	31	51	7. vi.	119.0	845	1369
10. v.	16.9	120	194	8. vi.	115.3	819	1326
11. v.	4.5	32	52	9. vi.	92.5	657	1064
12. v.	0.0	0	0	10. vi.	65.0	462	748
13. v.	0.0	0	0	11. vi.	0.0	0	0
14. v.	7.0	50	101	12. vi.	0.0	0	0
15. v.	11.2	80	129	13. vi.	44.0	312	506
16. v.	12.2	87	140	14. vi.	103.6	736	1191
17. v.	13.3	94	153	15. vi.	194.5	1381	2237
18. v.	4.6	33	53	16. vi.	153.5	1090	1765
19. v.	9.0	64	104	17. vi.	207.8	1475	2390
20. v.	0.0	0	0	18. vi.	225.2	1599	2590
21. v.	0.0	0	0	19. vi.	88.6	629	1019
22. v.	0.0	0	0	20. vi.	191.1	1357	2198
23. v.	10.8	77	124	21. vi.	164.8	1170	1895
24. v.	50.8	361	584	22. vi.	152.5	1083	1754
25. v.	67.3	478	774	23. vi.	133.4	947	1534
26. v.	62.8	446	722	24. vi.	0.0	0	0
27. v.	64.1	455	737	25. vi.	31.0	220	357
28. v.	71.3	506	820	26. vi.	0.0	0	0
29. v.	43.0	305	495				

Table 66. The same as above. No. 17.

Date	V	O	W	Date	V	O	W
26. iv.	1.2	9	14	29. v.	0.0	0	0
27. iv.	1.4	10	16	30. v.	83.8	595	964
28. iv.	2.0	14	23	31. v.	117.5	834	1351
29. iv.	5.0	36	58	1. vi.	120.8	858	1389
30. iv.	11.0	78	127	2. vi.	184.0	1306	2116
1. v.	6.0	43	69	3. vi.	189.6	1346	2180
2. v.	13.0	92	150	4. vi.	185.1	1314	2129
3. v.	17.3	123	199	5. vi.	149.8	1064	1723
4. v.	8.0	57	92	6. vi.	61.1	434	703
5. v.	19.5	138	224	7. vi.	0.0	0	0
6. v.	12.3	87	141	8. vi.	311.3	2210	3580
7. v.	9.0	64	104	9. vi.	261.2	1855	3004
8. v.	21.8	155	251	10. vi.	277.9	1973	3196
9. v.	5.2	37	59	11. vi.	398.3	2828	4580
10. v.	0.0	0	0	12. vi.	0.0	0	0
11. v.	37.5	266	431	13. vi.	320.8	2278	3689
12. v.	33.0	734	380	14. vi.	262.6	1864	3020
13. v.	26.2	186	301	15. vi.	265.0	1882	3048
14. v.	27.9	198	321	16. vi.	0.0	0	0
15. v.	39.5	283	464	17. vi.	0.0	0	0
16. v.	42.5	302	489	18. vi.	465.5	3305	5353
17. v.	48.0	341	552	19. vi.	532.7	3782	6126
18. v.	24.8	176	285	20. vi.	505.0	3586	5808
19. v.	0.0	0	0	21. vi.	394.4	2800	4536
20. v.	15.0	107	173	22. vi.	680.7	4833	7828
21. v.	57.0	405	676	23. vi.	443.5	3149	5100
22. v.	64.4	457	740	24. vi.	671.0	4764	7717
23. v.	85.9	610	988	25. vi.	621.0	4409	7142
24. v.	60.5	430	696	26. vi.	543.8	3861	6254
25. v.	69.2	491	796	27. vi.	0.0	0	0
26. v.	76.3	522	877	28. vi.	0.0	0	0
27. v.	72.0	511	828				
28. v.	34.0	241	391				

Table 67. The same as above. No. 18.

Date	V	O	W	Date	V	O	W
29. iv.	2.0	14	23	17. v.	3.0	21	35
30. iv.				18. v.	7.6	54	87
1. v.	3.0	21	35	19. v.	16.2	115	185
2. v.	5.8	41	67	20. v.	26.4	187	304
3. v.	9.0	64	104	21. v.	20.0	142	230
4. v.	4.6	33	53	22. v.	33.4	237	384
5. v.	7.9	56	91	23. v.	20.9	148	240
6. v.	4.8	34	55	24. v.	25.8	1183	297
7. v.	7.5	53	86	25. v.	15.7	111	181
8. v.	12.0	85	138	26. v.	33.2	236	382
9. v.	20.2	143	232	27. v.	31.1	221	358
10. v.	17.9	127	206	28. v.	9.3	66	107
11. v.	41.2	293	474	29. v.	0.0	0	0
12. v.	0.0	0	0	30. v.	8.6	61	99
13. v.	0.0	0	0	31. v.	8.6	61	99
14. v.	10.4	74	120	1. vi.	11.0	78	127
15. v.	5.3	38	61				
16. v.	5.0	36	58				

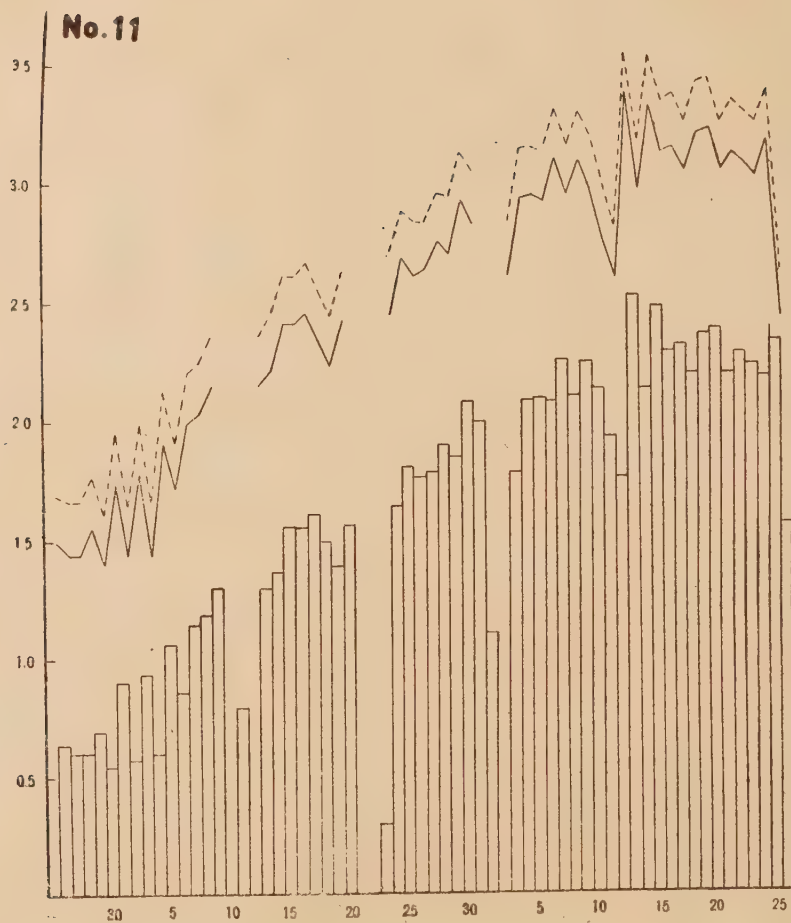
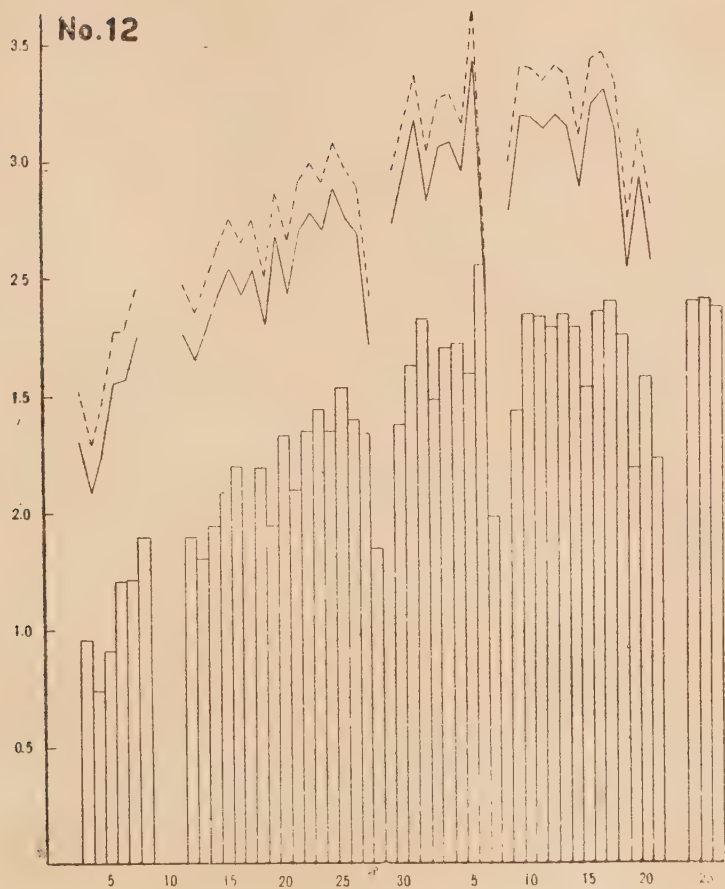
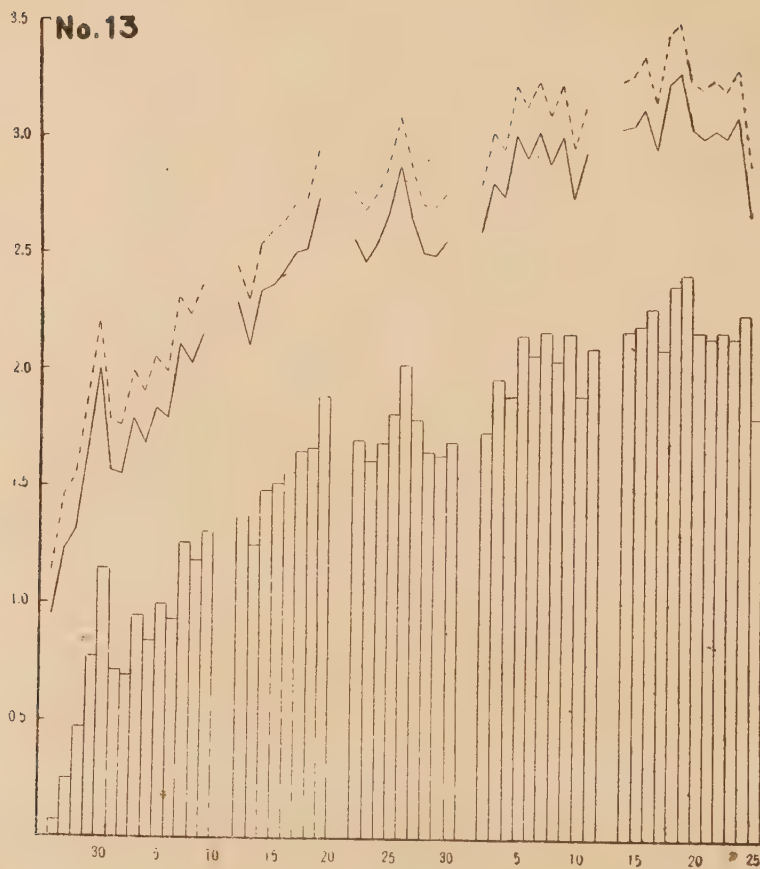
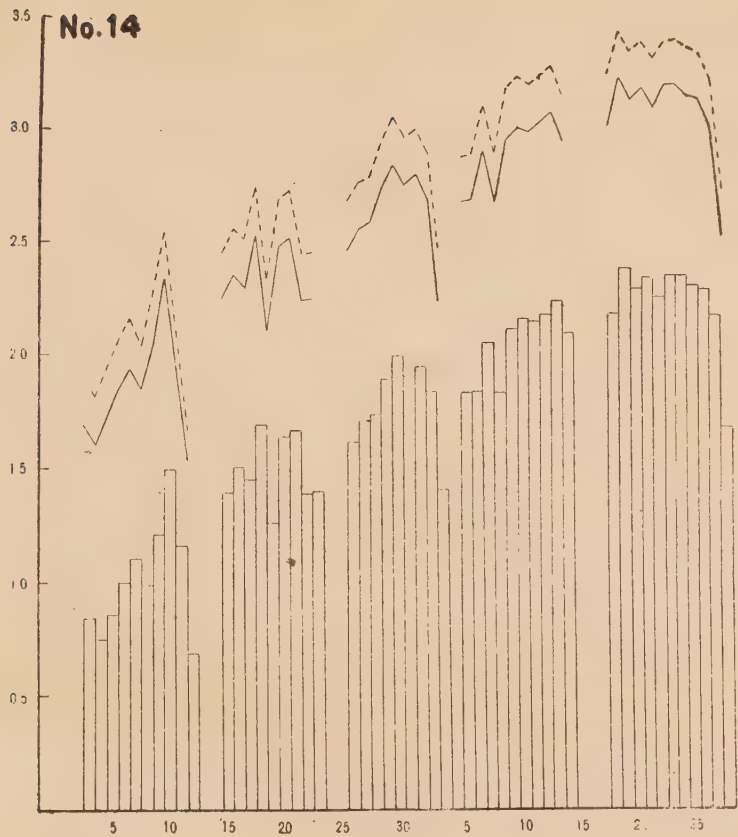
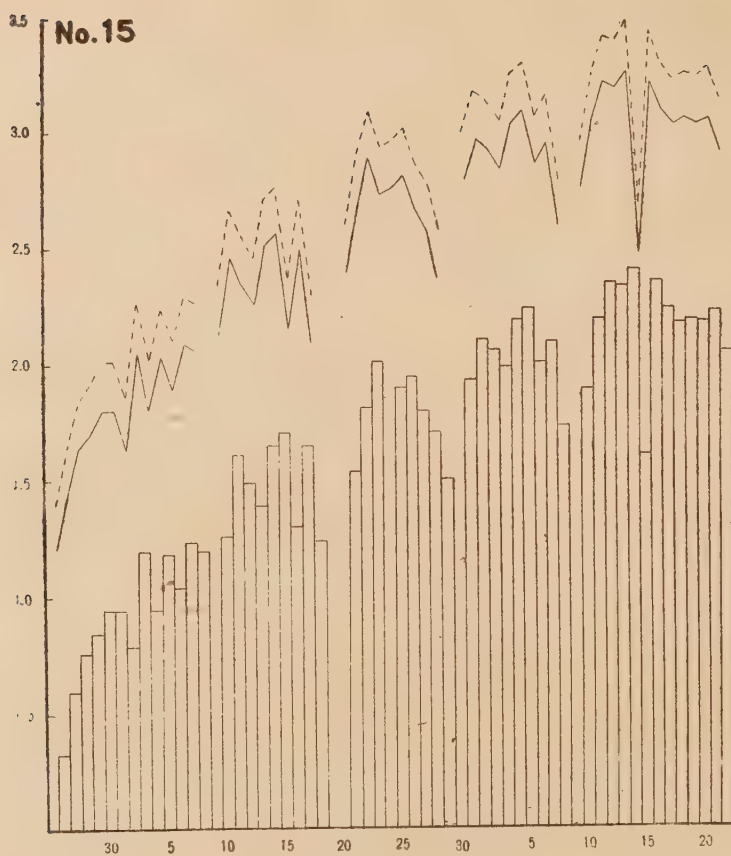


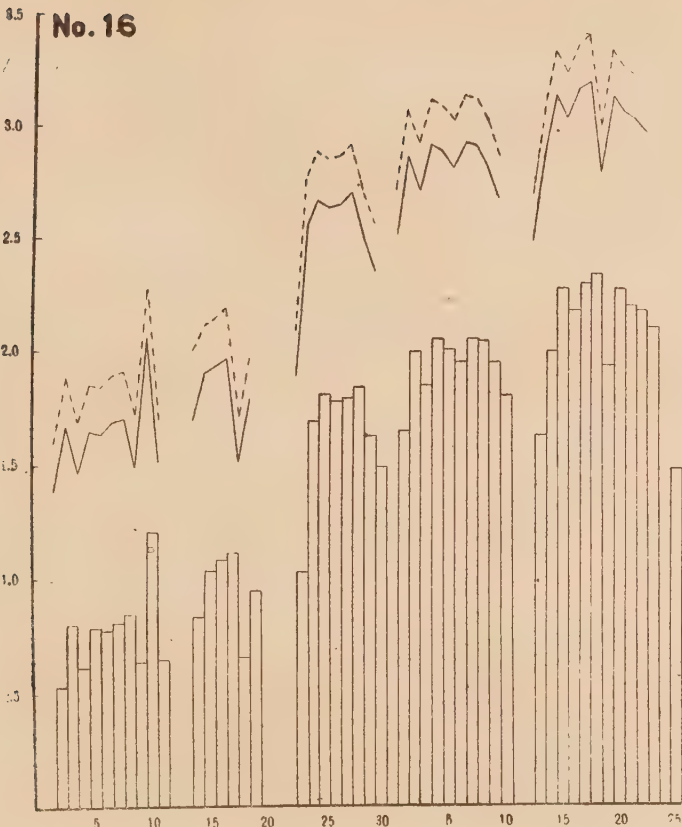
Fig. 30. Amount of leaves eaten by *Phraortes kumamotoensis* during the larval stadia.

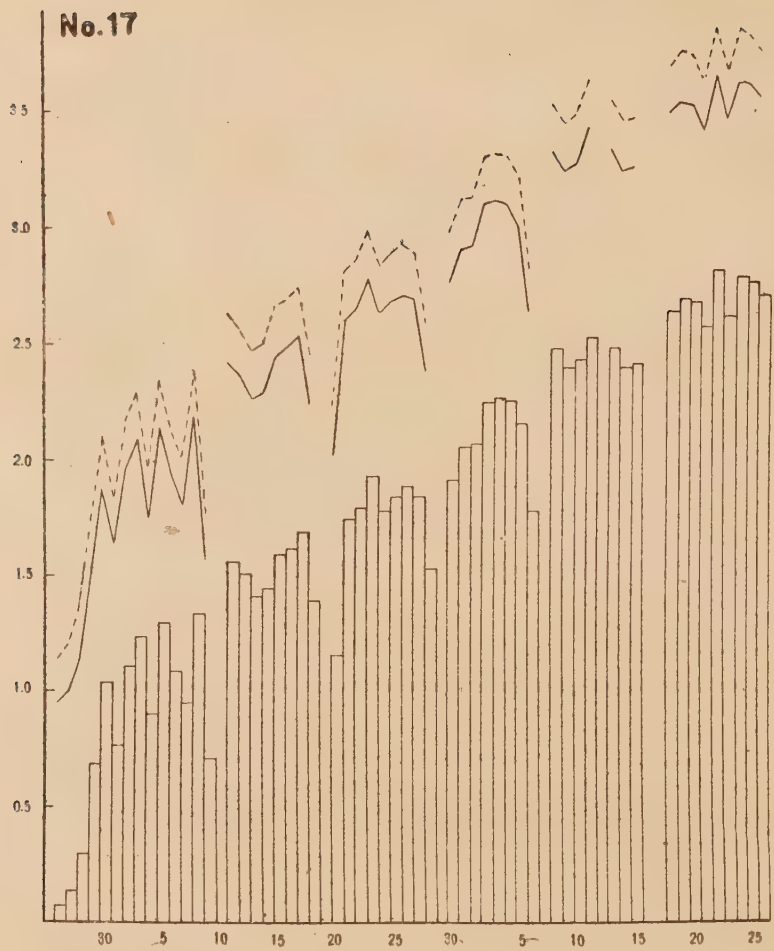












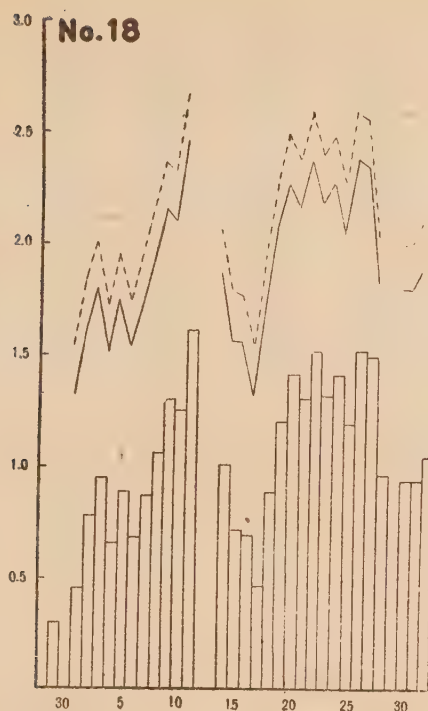


Table 68. Amount of leaves eaten by *Phraortes kumamotoensis* in each larval instar. No. 1.

Larval stadia	ΣV	ΣO	ΣW	F(%)	O'	W'
I	141.0	973	1293	1.9	1.22	1.62
II	387.0	2669	3562	5.0	3.33	4.45
III	500.2	3451	4601	6.4	4.31	5.75
IV	795.0	5485	7314	10.1	6.86	9.14
V	1874.0	12932	17241	23.9	16.16	21.55
VI	4128.5	28594	37989	52.7	35.74	47.49
I - II	528.0	3642	4855	6.9	4.55	6.07
I - III	1028.2	7093	9456	13.3	8.86	11.82
I - IV	1823.2	12578	16770	23.4	15.72	20.96
I - V	3692.2	25510	34011	47.3	31.88	42.51
I - VI	7825.7	54104	72000	100.0	67.62	90.00

II - III	887.2	6120	8163	11.4	7.64	10.20
II - IV	1682.2	11605	15477	21.5	14.50	19.34
II - V	3556.2	24537	32718	45.4	30.66	40.48
II - VI	6684.7	53131	70707	98.1	66.40	87.97
III - IV	1295.2	8936	11915	16.5	11.17	14.89
III - V	3169.2	21868	29156	40.4	27.33	36.44
III - VI	6297.7	50462	67145	93.1	63.07	83.93
IV - V	2669.0	18417	23555	34.0	23.02	30.69
IV - VI	6797.5	47011	61544	86.7	58.76	78.18
V - VI	6002.5	41526	55230	76.6	51.90	69.04

Table 69. The same as above. No. 2.

Larval stadia	ΣV	ΣO	ΣW	F(%)	O'	W'
I	143.0	985	1311			

Table 70. The same as above. No. 3.

Larval stadia	ΣV	ΣO	ΣW	F(%)	O'	W'
I	232.9	1607	2144	4.8	1.53	2.04
II	359.2	2477	3305	7.4	2.36	3.15
III	605.3	4176	5568	12.5	3.98	5.30
IV	1117.9	7722	10295	23.2	7.35	9.80
V	2494.7	17124	22950	52.1	16.31	21.86
I - II	592.1	4084	5449	12.2	3.89	5.19
I - III	1197.4	8260	11017	24.7	7.87	10.49
I - IV	2315.3	15982	21312	47.9	15.22	20.29
I - V	4810.0	33106	44262	100.0	31.53	42.15
II - III	964.5	6653	8873	19.9	6.34	8.45
II - IV	2082.4	14375	19168	43.1	13.69	18.20
II - V	4577.1	31499	42118	95.2	80.00	40.11
III - IV	1723.2	11898	15863	35.7	11.33	15.10
III - V	4217.9	29022	38813	87.8	27.64	36.96
IV - V	3612.6	24846	33245	75.3	23.66	31.66

Table 71. The same as above. No. 4

Larval stadia	ΣV	ΣO	ΣW	F(%)	O'	W'
I	197.8	1394	1820	2.7	1.39	1.86
II	329.7	2274	3034	4.5	2.33	3.10
III	464.9	3207	4276	6.3	3.27	4.36
IV	927.8	6402	8534	12.7	6.53	8.71
V	2043.4	14000	17800	27.8	14.29	18.16
VI	3335.5	23015	30687	46.0	23.48	31.31
I - II	527.5	3638	4854	7.2	3.72	4.96
I - III	992.4	6845	9130	13.5	6.99	9.32
I - IV	1920.2	13247	17664	26.2	13.52	18.03
I - V	3963.6	27247	35464	54.0	27.81	36.19
I - VI	7299.1	50262	66151	100.0	51.29	67.50
II - III	794.6	5481	7310	10.8	5.60	7.46
II - IV	1722.4	11883	15844	23.6	11.13	16.17
II - V	3765.8	25883	33644	51.3	25.42	34.33
II - VI	7101.3	48898	64331	97.3	48.90	65.64
III - IV	1392.7	9609	12810	19.0	9.80	13.07
III - V	3436.1	23609	30610	46.8	24.09	31.23
III - VI	6771.6	46624	61297	92.8	47.57	62.54
IV - V	2971.2	20402	26334	40.5	20.82	26.87
IV - VI	6306.7	43417	57021	86.5	44.30	58.18
V - VI	5378.9	37015	43487	73.8	37.77	49.47

Table 72. The same as above. No. 5.

Larval stadia	ΣV	ΣO	ΣW	F(%)	O'	W'
I	164.0	1064	1418	3.0	0.89	1.18
II	321.4	2219	2956	6.0	1.85	2.46
III	549.3	3791	5052	10.2	3.16	4.21
IV	963.0	6649	8865	17.9	5.54	7.39
V	3353.2	23238	30848	62.9	19.37	25.71
I - II	485.4	3283	4374	9.0	2.74	3.64
I - III	1034.7	7074	9426	19.2	5.90	7.85
I - IV	1997.7	13723	18291	37.1	11.44	15.24
I - V	5350.9	36961	49139	100.0	30.81	40.95

II - III	870.7	6010	8008	16.2	5.01	6.67
II - IV	1833.7	12659	16873	34.1	10.55	14.06
II - V	5186.9	35897	47721	97.0	29.92	39.77
III - IV	1212.3	10440	13917	28.1	8.70	11.60
III - V	4565.5	33678	44765	91.0	28.07	37.31
IV - V	4316.2	29887	39713	80.8	24.91	33.10

Table 73. The same as above. No. 6.

Larval stadia	ΣV	ΣO	ΣW	F(%)	O'	W'
I	172.3	1189	1587	1.9	1.14	1.53
II	306.7	2116	2823	3.3	2.04	2.71
III	592.4	4088	5451	6.5	3.82	5.24
IV	984.1	6689	9053	10.8	6.43	8.70
V	2019.3	13933	18577	22.1	13.40	17.86
VI	5026.7	34683	46246	55.4	33.35	44.46
I - II	479.0	3305	4410	5.2	3.18	4.24
I - III	1071.4	7393	9861	11.7	7.00	9.48
I - IV	2055.5	14082	18914	22.5	13.43	18.18
I - V	4074.3	28015	37491	44.6	26.83	36.04
I - VI	9101.5	92698	73737	100.0	60.18	80.51
II - III	899.1	6204	8274	9.8	5.86	7.95
II - IV	1883.2	12893	17327	20.6	12.29	16.65
II - V	3902.5	26826	35904	42.7	25.69	34.51
II - VI	8929.2	61509	82150	98.1	59.04	78.98
III - IV	1576.5	10777	14504	17.3	10.25	13.94
III - V	3595.8	24710	33081	38.4	23.65	31.80
III - VI	8622.5	59393	79327	93.8	57.00	76.27
IV - V	3003.4	20622	27630	32.9	19.83	26.56
IV - VI	8030.1	55305	73876	88.3	53.18	71.03
V - VI	7046.0	48616	64823	77.5	46.75	62.33

Table 74. The same as above. No. 7.

Larval stadia	ΣV	ΣO	ΣW	F(%)	O'	W'
I	233.7	1613	2149	4.8	3.34	4.48
II	468.4	3230	4301	9.6	6.73	8.96
III	704.8	4863	6485	14.5	10.13	13.51
IV	1138.4	7854	10473	23.5	16.36	21.81
V	2289.8	15800	21066	47.6	32.92	43.89
I - II	702.1	4843	6457	14.4	10.07	13.44
I - III	1406.9	9706	12942	28.9	20.20	26.95
I - IV	2545.3	17560	23415	52.4	36.56	48.76
I - V	4835.1	33360	44481	100.0	69.48	92.65
II - III	1173.2	8093	10786	24.1	16.86	22.47
II - IV	2311.6	15947	21259	47.6	33.22	44.28
II - V	4601.4	31747	42325	95.2	66.14	88.17
III - IV	1843.2	12717	16958	39.0	26.49	35.32
III - V	3133.0	28517	38024	86.6	59.41	79.21
IV - V	3428.2	23654	31539	71.1	49.28	65.70

Table 75. The same as above. No. 8.

Larval stadia	ΣV	ΣO	ΣW	F(%)	O'	W'
I	171.7	1184	1578	2.2	1.18	1.58
II	454.8	3138	4186	5.7	3.14	4.19
III	573.9	3979	5279	7.2	3.98	5.28
IV	970.3	6695	8976	12.3	6.70	8.91
V	1761.4	12154	16205	22.3	12.15	16.21
VI	3939.7	27185	36246	50.3	27.19	36.25
I - II	626.5	4322	5764	7.9	4.32	5.77
I - III	1200.4	8301	11034	15.1	8.30	11.05
I - IV	2170.7	14996	19949	27.4	15.00	19.96
I - V	3932.1	27150	36154	49.7	27.15	36.17
I - VI	7871.8	54335	72400	100.0	54.34	72.42
II - III	1028.7	7117	9465	12.9	7.12	9.47
II - IV	1999.0	13812	18371	25.2	13.82	18.38
II - V	3760.4	25966	34576	47.5	25.97	34.59
II - VI	7700.1	53151	70822	97.8	53.16	70.84

III - IV	1544.2	10674	14188	19.5	10.68	14.19
III - V	3305.6	22828	30393	41.8	22.83	30.40
III - VI	7245.3	50013	66639	92.1	50.02	66.65
IV - V	2731.7	18849	25111	34.6	18.85	25.12
IV - VI	6671.4	46037	61357	84.9	46.84	61.37
V - VI	5701.1	39339	52451	72.6	39.34	52.46

Table 76. The same as above. No. 9.

Larval stadia	ΣV	ΣO	ΣW	F(%)	O'	W'
I	175.2	968	1299	4.3	0.83	1.11
II	327.0	2255	3008	8.1	1.93	2.57
III	539.3	3621	4840	13.3	3.09	4.14
IV	847.6	5849	7800	21.0	5.00	6.67
V	2146.3	14811	19745	53.3	12.66	16.88
I - II	502.2	3223	4307	12.4	2.76	3.68
I - III	1041.5	6844	9147	25.7	5.85	7.82
I - IV	1889.1	12693	16947	46.7	10.85	14.49
I - V	4035.4	27504	36692	100.0	23.51	31.37
II - III	866.3	5876	7848	21.4	5.02	6.71
II - IV	1713.9	11725	15648	42.4	10.02	13.38
II - V	3860.2	26535	35393	95.7	22.68	30.26
III - IV	1386.9	9470	12640	34.3	8.09	10.81
III - V	3533.2	24281	32385	82.6	20.75	27.69
IV - V	2993.9	20660	27545	74.3	17.66	23.55

Table 77. The same as above. No. 10.

Larval stadia	ΣV	ΣO	ΣW	F(%)	O'	W'
I	161.0	1100	1480			
II	246.3	1699	2268			
I - II	407.3	2799	3748			

Table 78. Amount of leaves eaten by *Phraortes kumamotoensis* in each larval instar. No. 11.

Larval stadia	ΣV	ΣO	ΣW	F(%)	O'	W'
I	113.8	810	1309	2.2	0.82	1.38
II	257.7	1830	2964	5.1	1.93	3.12
III	625.0	4427	7189	12.4	4.66	7.57
IV	1155.5	8205	13290	23.2	8.64	13.99
V	2861.5	20318	31910	57.1	21.39	34.64
I - II	371.5	2130	4273	7.3	2.75	4.50
I - III	996.5	6557	11462	19.7	7.41	12.07
I - IV	2152.0	14762	24752	42.9	16.05	26.06
I - V	5013.5	35080	57662	100.0	37.44	60.70
II - III	882.7	6257	10153	17.5	6.49	10.69
II - IV	2038.2	14462	23443	40.7	15.13	24.68
II - V	4899.7	34780	56353	97.8	36.52	59.32
III - IV	1780.5	12632	20479	35.6	13.30	21.56
III - V	4642.0	32950	53389	92.7	34.69	56.20
IV - V	4017.0	28523	46200	80.3	30.03	48.63

Table 79. The same as above. No. 12.

Larval stadia	ΣV	ΣO	ΣW	F(%)	O'	W'
III	912.0	6474	10489			
IV	1403.8	9968	16143			
V	2183.2	15502	25108			
III - IV	2315.8	16442	26632			
III - V	4499.0	31944	51740			
IV - V	3587.0	25470	41251			

Table 80. The same as above. No. 13.

Larval stadia	ΣV	ΣO	ΣW	F(%)	O'	W'
I	126.6	901	1459	3.2	0.64	1.04
II	312.2	2239	3690	7.8	1.60	2.64
III	515.1	3857	5923	12.9	2.76	4.23
IV	1088.3	7737	12517	27.6	5.53	8.94
V	1927.3	13684	22158	48.5	9.77	15.83
I - II	438.8	3140	5149	11.0	2.24	3.68
I - III	953.9	6997	11072	23.9	5.00	7.91
I - IV	2042.2	14734	23589	51.5	10.53	16.85
I - V	3969.5	28418	45747	100.0	20.30	32.68
II - III	827.3	6096	9613	20.7	4.36	6.87
II - IV	1915.6	13833	22130	48.3	9.89	15.81
II - V	3842.9	27517	44288	96.8	19.66	31.64
III - IV	1603.4	11594	18440	40.5	8.29	13.17
III - V	3530.7	25278	40598	89.0	18.06	29.00
IV - V	3015.6	21421	34675	76.1	15.30	24.77

Table 81. The same as above. No. 14.

Larval stadia	ΣV	ΣO	ΣW	F(%)	O'	W'
I	119.1	844	1371	2.7	0.89	1.44
II	293.0	2082	3371	6.7	2.19	3.55
III	593.5	4216	6826	13.7	4.44	7.19
IV	1209.5	8586	13908	28.0	9.04	14.64
V	2100.0	14908	24151	48.9	15.69	25.42
I - II	412.1	2926	4742	9.4	3.08	4.99
I - III	1005.6	7142	11568	23.1	7.52	12.18
I - IV	2215.1	15728	25476	51.1	16.56	26.82
I - V	4315.1	30636	49627	100.0	32.25	52.24
II - III	886.5	6298	10197	20.4	6.63	10.74
II - IV	2096.0	14884	24105	48.4	15.67	25.38
II - V	4196.0	29792	48256	97.3	31.36	50.80
III - IV	1803.0	12802	20734	41.7	13.48	21.83
III - V	3903.0	27710	44885	90.6	19.17	47.25
IV - V	3309.5	23494	38059	76.9	24.73	40.06

Table 82. The same as above. No. 15.

Larval stadia	ΣV	ΣO	ΣW	F(%)	O'	W'
I	128.2	912	1478	3.0	1.01	1.64
II	293.9	1988	3382	6.8	2.21	3.65
III	601.7	4273	6920	14.1	4.75	7.80
IV	1051.4	7466	12090	24.7	8.30	13.43
V	2186.3	15522	25142	51.4	17.25	27.94
I - II	422.1	2900	4860	9.8	3.22	5.29
I - III	1023.8	7173	11780	23.9	7.97	13.09
I - IV	2075.2	14639	23870	48.6	16.27	26.52
I - V	4261.5	30161	49012	100.0	33.52	54.46
II - III	895.6	6261	10302	20.9	6.96	11.45
II - IV	1947.0	13727	22392	45.6	15.26	24.88
II - V	4133.3	29249	47534	97.0	32.51	52.82
III - IV	1653.1	11739	19010	38.8	13.05	21.23
III - V	3839.4	27261	44152	90.2	30.30	49.17
IV - V	3237.7	22988	37232	76.1	25.55	41.37

Table 83. The same as above. No. 16.

Larval stadia	ΣV	ΣO	ΣW	F(%)	O'	W'
II	123.6	879	1442	4.1	0.73	1.20
III	401.9	2854	4622	12.7	2.38	3.85
IV	931.9	6617	10718	29.6	5.51	8.93
V	1690.0	11989	19436	53.6	9.99	16.20
II - III	525.5	3733	6064	16.8	3.11	5.05
II - IV	1457.4	10350	16782	46.4	8.62	13.98
II - V	3147.4	22339	36218	100.0	18.61	30.18
III - IV	1333.8	9571	15340	42.3	7.89	12.78
III - V	3023.8	21560	34776	95.9	12.88	28.98
IV - V	2621.9	18606	30154	83.2	15.50	25.13

Table 84. The same as above. No. 17.

Larval stadia	ΣV	ΣO	ΣW	F(%)	O'	W'
I	132.7	943	1527	1.4	0.38	0.62
II	279.4	2486	3223	3.1	1.01	1.32
III	534.3	3774	6170	5.9	1.54	2.52
IV	1091.7	7751	12555	12.1	3.16	5.12
V	2097.1	14890	24117	23.3	6.08	9.84
VI	4857.6	34489	55864	54.2	14.08	22.80
I - II	412.1	3429	4750	4.5	1.39	1.94
I - III	946.4	7203	10902	10.4	2.93	4.46
I - IV	2038.1	14954	23475	22.5	6.09	9.58
I - V	4135.2	29844	47592	45.8	12.17	19.42
I - VI	8992.8	64333	103459	100.0	26.25	42.22
II - III	813.7	6260	9393	9.0	2.55	3.84
II - IV	1905.4	13011	21948	21.1	5.71	8.96
II - V	4002.5	28901	46065	44.4	11.79	18.80
II - VI	8860.1	63390	102029	98.6	25.87	41.60
III - IV	1626.0	11525	18725	18.0	4.70	7.64
III - V	3723.1	26415	42842	41.3	10.78	17.48
III - VI	8580.7	60904	98706	95.5	24.86	40.28
IV - V	3188.8	22641	36672	35.4	9.24	14.96
IV - VI	8046.4	57130	92536	89.6	23.32	37.76
V - VI	6954.7	49379	79981	77.5	20.16	32.64

Table 85. The same as above. No. 18.

Larval stadia	ΣV	ΣO	ΣW	F(%)	O'	W'
I	135.9	964	1564			
II	263.3	1869	3030			
I - II	399.2	2833	4594			

Observations

The object of the experiments mentioned above was to examine the food consumption of normally developing larvae of *Phraortes kumamotoensis*. For this purpose two classes of feeding experiments were performed. In the first, the leaves of *Lyonia Neziki* NAKAI et HARA (Ericaceae) were given three times a day (8 o'clock, 13 o'clock, 17 o'clock); whilst in the second *Prunus subhirtella* MIQUEL, a member of the Family Rosaceae, taxonomically not close to the Ericaceae, was used. It seems to be convenient to show here an example of the differences between the leaves of the two species of plants on which the insects were fed.

Table 86. Differences between the leaves of *Lyonia Neziki* and *Prunus subhirtella* on July 15th. Measurements were carried out on the leaves of 400 mm³ in volume.

Food plants	<i>Lyonia Neziki</i>	<i>Prunus subhirtella</i>
Live weight	0.0650 gr.	0.0770 gr
Dry weight	0.0280 gr.	0.0310 gr.
Water contents	0.0370 gr.	0.0460 gr.
Organic matter contents	0.0276 gr.	0.0275 gr.
Ash contents	0.0004 gr.	0.0025 gr.

As shown in the tables given before, there is wide variation in the duration of each instar even of those fed on the same food and under the same rearing conditions. But one might say that the total length of the post-embryonic growth period in each individual showed a much closer value to the mean of a number of cases. This fact proves that the development during the course of the present experiments was normal and ideal.

In spite of the irregularities, a general trend, indicating a similarity in food consumption, was to be noted in all the individuals. Several interesting and instructive points may be taken from these tables and figures.

Approximately 50 per cent of the total volume of food consumed during the entire larval period was taken during the last

sixth stadium (sixth in the female and fifth in the male). The relation may be written:

$$V_6 = V_1 + V_2 + V_3 + V_4 + V_5 \dots \text{♀} \dots (1)$$

$$V_5 = V_1 + V_2 + V_3 + V_4 \dots \text{♂} \dots (2)$$

Approximately 50 per cent of food consumed during the stadia except the last was taken in the last stadium but one (fifth in the female, fourth in the male). The relation takes the form:

$$V_6 = V_1 + V_2 + V_3 + V_4 \dots \text{♀} \dots (3)$$

$$V_4 = V_1 + V_2 + V_3 \dots \text{♂} \dots (4)$$

Similar relation was observed also in the preceding stadium and it may be expressed:

$$V_4 = V_1 + V_2 + V_3 \dots \text{♀} \dots (5)$$

$$V_3 = V_1 + V_2 \dots \text{♂} \dots (6)$$

In the female the similar relation was again observed in the third larval stadium, thus:

$$V_3 = V_1 + V_2 \dots \text{♀} \dots (7)$$

In both sexes the amount of the food consumption in the second stadium becomes approximately equal to a doubling of that in the first stadium. This may take the form:

$$V_2 = 2V_1 \dots \text{♀} \text{♂} \dots (8)$$

From the eight empirical formulae above cited the following relations can be derived.

$$V_2 = 2V_1$$

$$V_3 = 2V_2 = 4V_1$$

$$V_4 = 2V_3 = 4V_2 = 8V_1$$

$$V_5 = 2V_4 = 4V_3 = 8V_2 = 16V_1$$

$$V_6 = 2V_5 = 4V_4 = 8V_3 = 16V_2 = 32V_1$$

Thus under normal conditions, the increase of food consumption with age may be well defined by the formula

$$V_n = 2^{n-1} V_1,$$

where V is either the volume of food or of the contents of

organic matter in it consumed in the stadium n , and V_1 is the same for the first stadium.

The food consumption of the two sexes is practically the same up to the fifth post-embryonic developmental stadia. As this insect exhibits five stadia in larval development in the case of the males, while six in the case of the females, the food consumed by the male in its larval period is approximately 50 per cent of that of the female.

Next, the amount of organic matter eaten by each individual during the post-embryonic developmental period in order to produce a unit weight (1 gram) of the adult was calculated in use of the dry weight of the mesothoracic exoskeleton as shown in the following tables.

Table 87. Organic matter (in gram) taken by the larvae to produce the unit weight of the adult female.

No.	Stadia					
	I	II	III	IV	V	VI
1	2.74	7.40	9.70	15.43	36.36	80.39
4	3.12	5.26	7.36	14.69	32.15	52.83
6	2.56	4.59	8.59	14.47	30.15	75.04
8	2.65	7.00	8.96	15.06	27.38	61.78
Average	2.76	6.06	8.65	14.91	31.51	67.53

Table 88. Organic matter (in gram) taken by the larvae to produce the unit weight of the adult male.

No.	Stadia				
	I	II	III	IV	V
3	3.44	5.31	9.00	16.50	36.69
5	2.00	4.16	7.11	12.50	43.50
9	1.86	4.34	7.00	11.30	28.40
11	1.84	4.34	10.48	19.40	48.10
13	1.44	3.60	6.21	12.40	22.09
14	2.00	4.92	9.99	22.30	35.30
15	2.27	4.97	10.68	18.70	38.31
Average	2.12	4.52	8.62	15.89	36.14

I	II	III	IV	V	VI	
						No. 1
						No. 4
						No. 6
						No. 8
						No. 17
						AVERAGE

Fig. 31. Relative amount of leaves eaten by the female of *Phraortes kumamotoensis* in each larval instar.

I	II	III	IV	V	
					No. 3
					No. 5
					No. 7
					No. 9
					No. 11
					No. 13
					No. 14
					No. 15
					AVERAGE

Fig. 32. Relative amount of leaves eaten by the male of *Phraortes kumamotoensis* in each larval instar.

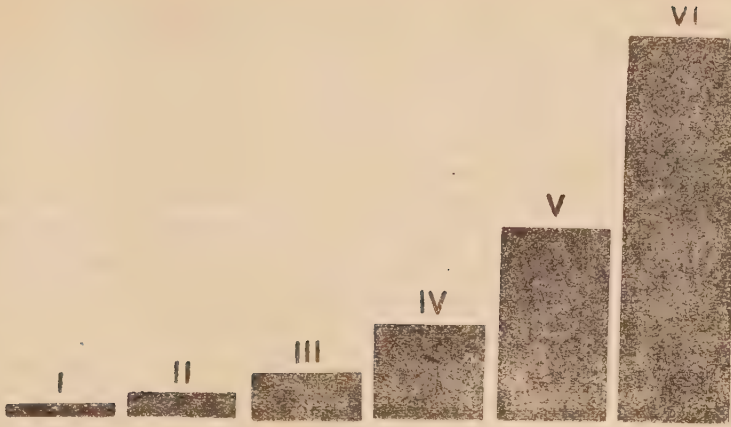


Fig. 33. A diagram showing the amount of leaves eaten by *Phraortes kumamotoensis* in each larval stadium.

- | | |
|--------------------|--------------------|
| I: First stadium | II: Second stadium |
| III: Third stadium | IV: Fourth stadium |
| V: Fifth stadium | VI: Sixth stadium |

2. Experiments Series 2

Experiments Class 3

No. 19, ♀ This insect underwent the fifth moult on June 17th, then having its weight 0.1015 gr. After a very long interval of 29 days, during which the larva attained a maximum weight of 0.3420 gr., the last moult took place on July 16th. The insect was killed on July 16th for measurement just after the last moult. The mesothorax was 14.6 mm in length and 0.0052 gr. in dry weight. $\Sigma V=4102.0$, $\Sigma O=28190$, $\Sigma W=37584$.

No. 20, ♂ On June 19th this insect underwent the fourth moult, then having its weight 0.0980 gr. After 16 days, during which it attained a maximum weight of 0.1854 gr., the last moult took place on July 4th. It was killed for measurement on July 5th. $\Sigma V=1601.8$, $\Sigma O=11042$, $\Sigma W=14725$.

No. 21, ♀ This insect underwent the fifth moult on June 18th, then having its weight 0.1050 gr. As in the case of No. 19, after a very long interval of 33 days, during which it attained a max-

imum weight of 0.4236 gr., the last moult took place on July 20th. The insect was killed for measurement on July 21st. The mesothorax was 15.0 mm in length and 0.0073 gr. in dry weight. $\Sigma V=5836.3$, $\Sigma O=39574$, $\Sigma W=52768$.

No. 22, ♂ This insect underwent the fourth moult on June 19th, then having its weight 0.1013 gr. After 17 days, during which it attained a maximum weight of 0.2125 gr., the last moult occurred on July 6th. The insect was killed for measurement on July 7th. The mesothorax was 13.4 mm in length and 0.0028 gr. in dry weight. $\Sigma V=1759.1$, $\Sigma O=11445$, $\Sigma W=15264$.

No. 23, ♂ This insect underwent the fourth moult on June 20th, then having its weight 0.0465 gr. After 19 days, during which it attained a maximum weight of 0.1547 gr., the last moult occurred on July 9th. The insect was killed for measurement on July 10th. The mesothorax was 10.0 mm in length and 0.0024 gr. in dry weight. $\Sigma V=1313.3$, $\Sigma O=9060$, $\Sigma W=12084$.

Experiments Class 4

No. 24, ♀ This insect underwent the fifth moult on July 1st, then having its weight 0.2000 gr. After a long time of 36 days this insect died on August 8th. and could not undergo the sixth moult. The mesothorax was 13.5 mm in length and 0.0098 gr. in dry weight. It attained a maximum weight of 0.3810 gr. two weeks before death. $\Sigma V=3222.5$, $\Sigma O=22235$, $\Sigma W=29648$.

No. 25, ♀ This insect underwent the fifth moult on June 20th, then having its weight 0.0914 gr. After a very long interval of 53 days this insect underwent the sixth moult and reached maturity on August 11th. The insect was killed after the last moult. The mesothorax was 12.0 mm in length and 0.0060 gr. in dry weight. It attained a maximum weight of 0.2500 gr. four days before the last moult. $\Sigma V=2543.5$, $\Sigma O=17451$, $\Sigma W=23401$.

No. 26, ♀ This insect underwent the fifth moult on June 20th, then having its weight 0.0854 gr. After a long interval of 23 days this insect died on July 12th and could not undergo the sixth moult. The mesothorax was 12.6 mm in length and 0.0075 gr. in dry weight. It attained a maximum weight of 0.1135 gr. a week before death. $\Sigma V=918.0$, $\Sigma O=6436$, $\Sigma W=8445$.

No. 27, ♂ This insect underwent the fourth moult on June 19th, then having its weight 0.1500 gr. After a very long interval of 42 days this insect died on July 12th and could not undergo the last moult. The mesothorax was 11.5 mm in length and 0.0032 gr. in dry weight. It attained a maximum weight of 0.1170 gr. a week before death. $\sum V=3090.8$, $\sum O=21326$, $\sum W=28434$.

No. 28, ♂ This insect underwent the fourth moult on June 20th, then having its weight 0.0892 gr. After 12 days this insect died on July 2nd and could not undergo the fifth moult. The mesothorax was 11.8 mm in length and 0.0033 gr. in dry weight. It attained a maximum weight of 0.1310 gr. three days before death. $\sum V=549.1$, $\sum O=3859$, $\sum W=5144$.

Experiments Class 6

No. 34, ♀ This insect underwent the fifth moult on July 18th, then having its weight 0.1172 gr. The insect then lived only 15 days and died on July 3rd. It attained a maximum weight of 0.1700 gr. eight days before death. The mesothorax was 13.2 mm in length and 0.0054 gr. in dry weight. $\sum V=401.7$, $\sum O=2772$, $\sum W=3695^6$.

No. 35, ♀ This insect underwent the fifth moult on July 17th, then having its weight 0.0790 gr. The insect then lived only nine days and died on July 25th.

No. 36, ♂ This insect underwent the fourth moult on June 22nd, then having its weight 0.0540 gr. The insect then lived only seven days and died on July 29th.

No. 37, ♂ This insect underwent the fourth moult on June 18th, then having its weight 0.1124 gr. The insect then lived as long as only two weeks, and could not undergo the last moult and died on July 2nd. $\sum V=204.3$, $\sum O=1410$, $\sum W=1779$.

No. 38, ♂ This insect underwent the fourth moult on June 19th, then having its weight 0.0965 gr. The insect then lived fifteen days, but could not undergo the last moult and died on July 3rd. $\sum V=422.0$, $\sum O=2912$, $\sum W=3882$.

Experiments Class 7

No. 39, ♂ The insect underwent the third moult on June 18th, then having its weight 0.1107 gr. After 17 days the insect underwent the fourth moult on July 4th, its body measured 0.2000 gr. This insect reached maturity 28 days later, on August 1st. The mesothorax was 13.2 mm in length and 0.0054 gr. in dry weight. It attained a maximum weight of 0.3128 gr. a week before the last moult. $\sum V=1113.5$, $\sum O=7682$, $\sum W=10258$ in the fourth instar. $\sum V=1584.0$, $\sum O=10932$, $\sum W=14573$ in the fifth instar.

No. 40, ♀ This insect underwent the fifth moult on June 18th, then having its weight 0.1100 gr. After a long interval of 40 days the insect died on July 27th and could not undergo the last moult. $\sum V=1702.3$, $\sum O=11747$, $\sum W=15665$.

No. 41, ♂ This insect underwent the fourth moult on June 20th, then having its weight 0.1140 gr. After a long interval of 23 days the insect reached maturity on July 12th. The mesothorax was 14.0 mm in length and 0.0036 gr. in dry weight. It attained a maximum weight of 0.1945 gr. three days before the last moult. $\sum V=1452.0$, $\sum O=10022$, $\sum W=13365$.

No. 42, ♂ This insect underwent the fourth moult on June 23rd, its body weighed 0.0734 gr. After a long interval of 28 days the insect died on July 20th and could not undergo the last moult. $\sum V=1481.3$, $\sum O=10227$, $\sum W=13583$.

No. 43, ♂ This insect underwent the fourth moult on June 18th, then having its weight 0.1130 gr. After a long interval of 23 days the insect reached maturity on July 11th. The mesothorax was 14.0 mm in length and 0.0050 gr. in dry weight. It attained a maximum weight of 0.2250 gr. three days before the last moult. $\sum V=1830.0$, $\sum O=12613$, $\sum W=16832$.

Observations

From the Experiments Class 3 the following fact can be derived. The duration of the sixth stadium is strongly lengthened. This result contrasts sharply with those reared normally.

Table 89. Duration of life in experimental and control stick insects.

No.	Stadium	Experimental	Control	
			Average	Maximum
19 ♀	VI	29 days	12.9 days	17.0 days
21 ♀	VI	33 days		
20 ♂	V	16 days	11.1 days	12.0 days
22 ♂	V	17 days		
23 ♂	V	19 days		

Although the length of the mesothorax in the experimental insects is either shorter than, or equal to, those of the normally fed insects, the dry weight of the same part of the former insects is exclusively smaller than those of the latter ones. It suggests from the above observations that the feeding on every other day in this insect is insufficient to complete the normal development. In other words, the feeding on every other day apparently affects the normal larval growth both in the duration of life and the dry weight of the body.

Similar and more exaggerative results were obtained from the Experiments Class 4. In these experimental insects the duration of the pre-adult stage was highly influenced and very much lengthened.

Table 90. Duration of life in experimental and control stick insects.

No.	Stadium	Experimental	Control	
			Average	Maximum
24 ♀	VI	36 days	12.9 days	17.0 days
25 ♀	VI	53 days		
26 ♀	VI	23 days		
27 ♂	V	42 days	11.1 days	12.0 days
28 ♂	V	Over 12 days		

Nos. 25 and 27 passed a very long time of the pre-adult stadium, making a remarkable contrast even to the maximum value in the normal growth (3.1 to 3.5-times). Further No. 28 could not undergo the final moult. The length of the mesothorax was also extremely influenced by the insufficient amount of food and very much shorter than that of the normal individuals. The dry weight of the mesothorax was mostly smaller than that of the normal individuals. Thus the feeding three times on every third day was much more insufficient than that on every other day.

In the Experiments Class 6 all the insects could not undergo the final moult and died 7-15 days after the moult previous to the last one. In this series of experiments it was necessary to supply water at least once a day. Very interesting was the fact that the insects which were obliged to hunger over two days did not respond quickly to food so long as they did not drink water.

Experiments Class 7 was fundamentally in agreement with those obtained in classes 3 and 4. The duration of the pre-adult stadium was strongly lengthened as seen in the following table.

Table 91. Duration of life in experimental and control stick insects.

No.	Stadium	Experimental	Control	
			Average	Maximum
39 ♂	V	17 days	11.1 days	12.0 days
40 ♀	VI	40 days	12.9 days	17.0 days
41 ♂	V	23 days	11.1 days	12.0 days
42 ♂	V	Over 28 days		
43 ♂	V	23 days		

No. 42 could not undergo the last moult. The length of the mesothorax was either smaller than or equal to that of the normally fed insects. But the dry weight of the mesothorax was always smaller than that of the normally fed individuals. From this experiment it is clear that the feeding once a day was also insufficient to complete the normal growth.

Experiments Series 3

Experiments Class 5

No. 29, ♀ This insect underwent the fifth moult on June 17th and arrived at maturity 19 days later, on July 6th, its mesothorax measured 16.5 mm in length and 0.0076 gr. in dry weight.

$\Sigma V = 6178.8$, $\Sigma O = 30900$, $\Sigma W = 38307$.

No. 30, ♀ This insect underwent the fifth moult on June 17th and reached maturity on July 6th, its mesothorax measured 18.8 mm in length and 0.0125 gr. in dry weight. $\Sigma V = 6836.0$, $\Sigma O = 34183$, $\Sigma W = 42386$.

No. 31, ♀ This insect underwent the fifth moult on June 16th and reached maturity 19 days later, on July 4th, its mesothorax measured 17.5 mm in length and 0.0112 gr. in dry weight.

$\Sigma V = 7124.8$, $\Sigma O = 35669$, $\Sigma W = 44244$.

No. 32, ♂ This insect underwent the fourth moult on June 16th and attained maturity 17 days later, on July 3rd. The mesothorax was 15.5 mm in length and 0.0075 gr. in dry weight.

$\Sigma V = 2224.0$, $\Sigma O = 11125$, $\Sigma W = 13790$.

No. 33, ♂ This insect underwent the fourth moult on June 19th and reached maturity 14 days later, on July 3rd, its mesothorax measured 17.0 mm in length and 0.0100 gr. in dry weight.

$\Sigma V = 2433.7$, $\Sigma O = 12171$, $\Sigma W = 15090$.

Observations

Experimental insects, Nos. 29-33, were fed on the foliage of *Amelanchier asiatica* C. KOCH (Rosaceae). An example of the measurements of the leaves of 400 mm³ in volume of this plant is given in the following lines (July 15th).

Live weight	0.0457 gr.
Dry weight	0.0209 gr.
Water contents	0.0248 gr.
Organic matter contents	0.0201 gr.
Ash contents	0.0008 gr.

From the above measurements it is evident that the unit volume of the leaves of *Amelanchier asiatica* contains a smaller

amount of water or organic matter in comparison with that of *Lyonia Neziki* or *Prunus subhirtella*. This would be apparently the probable reason that the females, Nos. 29-31, exhibited the greater values of $\sum V$, i.e. 6178.8, 6836.0 and 7124.8 respectively, than those of the insects fed on *Lyonia Neziki* or *Prunus subhirtella*. On the other hand, the males, Nos. 32-33, consumed an almost equal amount of food as that of Nos. 1-19. This fact may indicate the existence of the fundamental differences in the requirement of nourishment between the sexes. In correlation with this fact it may be reasonable that the duration of the sixth stadium was a little lengthened in the female sex. It follows from the above experiments that each of the three kinds of plants represents an adequate diet for this stick insect to complete the normal post-embryonic development.

Table 92. Growth in weight of *Phraortes kumamotoensis* in larval period.

Date	No. 19	No. 20	No. 21	No. 22	No. 23
17. vii.	0.1015				
18. vii.	0.1000		0.1050		
19. vii.	0.1355	0.0980	0.1220	0.1013	
20. vii.	0.1179	0.0890	0.1161	0.0930	0.0465
21. vii.	0.1657	0.1180	0.1620	0.1241	0.0741
22. vii.	0.1434	0.1063	0.1425	0.1135	0.0655
23. vii.	0.1676	0.1362	0.1591	0.1430	0.0785
24. vii.	0.1524	0.1240	0.1475	0.1320	0.0742
25. vii.	0.1875	0.1400	0.1940	0.1573	0.0906
26. vii.	0.1621	0.1282	0.1638	0.1436	0.0900
27. vii.	0.2030	0.1600	0.2146	0.1780	0.1100
28. vii.	0.1800	0.1430	0.1771	0.1560	0.1095
29. vii.	0.1640	0.1740	0.2420	0.2008	0.1444
30. vii.	0.1521	0.1542	0.2119	0.1755	0.1133
31. vii.	0.2330	0.1854	0.2100	0.2182	0.1485
1. viii.	0.2100	0.1600	0.1880	0.1900	0.1300

2. viii.	0.2476	0.1558	0.2620	0.2125	0.1564
3. viii.	0.2128		0.2163	0.1957	0.1350
4. viii.	0.2600		0.2900	0.1930	0.1547
5. viii.	0.2260		0.2450		0.1436
6. viii.	0.2800		0.2912		0.1458
7. viii.	0.2520		0.2640		0.1500
8. viii.	0.2930		0.2656		
9. viii.	0.2700		0.2400		
10. viii.	0.3300		0.3220		
11. viii.	0.2900		0.2725		
12. viii.	0.3420		0.3461		
13. viii.	0.3095		0.3010		
14. viii.	0.3000		0.3737		
15. viii.			0.3200		
16. viii.			0.4236		
17. viii.			0.3735		
18. viii.			0.4100		
19. viii.			0.3830		

Table 93. Growth in weight of *Phraortes kumamotoensis* in larval period.

Date	No. 34	No. 35	No. 36	No. 37	No. 38
17. vii.		0.0900			
18. vii.	0.1172	0.0851		0.1124	
19. vii.	0.1118	0.0784		0.1000	0.0965
20. vii.	0.1335	0.0935		0.1135	0.1162
21. vii.	0.1554	0.1021		0.1491	0.1390
22. vii.	0.1400	0.0934		0.1366	0.1241
23. vii.	0.1339	0.0839	0.0540	0.1258	0.1200
24. vii.	0.1230	0.0790	0.0500	0.1140	0.1100
25. vii.	0.1500		0.0500	0.1455	0.1220
26. vii.	0.1700		0.0564	0.1600	0.1577
27. vii.	0.1500		0.0620	0.1484	0.1433
28. vii.	0.1380		0.0564	0.1198	0.1196

29. vii.	0.1285	0.0556	0.1084	0.1072
30. vii.	0.1503		0.1289	0.1670
31. vii.	0.1300		0.1141	0.1386
1. viii.	0.1200			0.1278
2. viii.				0.1095

Table 94. Growth in weight of *Phraortes kumamotoensis*
in larval period.

Date	No. 39	No. 40	No. 41	No. 42	No. 43
18. vii.	0.1107	0.1100			0.1130
19. vii.	0.1154	0.1280			0.1423
20. vii.	0.1188	0.1240	0.1140		0.1555
21. vii.	0.1430	0.1334	0.1336		0.1468
22. vii.	0.1558	0.1352	0.1335		0.1547
23. vii.	0.1700	0.1450	0.1490	0.0734	0.1599
24. vii.	0.1700	0.1350	0.1550	0.1000	0.1660
25. vii.	0.1700	0.1300	0.1435	0.1035	0.1635
26. vii.	0.1745	0.1145	0.1400	0.0940	0.1559
27. vii.	0.1665	0.1199	0.1395	0.1050	0.1651
28. vii.	0.1697	0.1140	0.1490	0.0934	0.1699
29. vii.					
30. vii.	0.2015	0.1409	0.1710	0.1250	0.2002
31. vii.	0.1988	0.1488	0.1889	0.1280	0.1800
1. viii.	0.1928	0.1520	0.1845	0.1134	0.1725
2. viii.	0.1940	0.1400	0.1840		0.1600
3. viii.		0.1450	0.1910	0.1100	
4. viii.		0.1400	0.1800	0.1000	
5. viii.	0.2000	0.1435	0.1780	0.1170	0.2120
6. viii.	0.2025	0.1571	0.1800		0.2170
7. viii.	0.2248	0.1580			
8. viii.	0.2020	0.1380	0.1945	0.1349	0.2250
9. viii.	0.2395	0.1330	0.1790	0.1320	0.2200
10. viii.	0.2400	0.1360	0.1750	0.1330	0.2100
11. viii.	0.2430	0.1400		0.1400	
12. viii.	0.2425	0.1440		0.1430	
13. viii.	0.2450	0.1400		0.1452	
14. viii.	0.2537	0.1400		0.1460	

15. viii.	0.2670	0.1490	0.1480
16. viii.	0.2775	0.1500	0.1495
17. viii.	0.2790	0.1535	0.1400
18. viii.	0.2680	0.1536	0.1564
19. viii.	0.2767	0.1500	0.1500
20. viii.	0.2850	0.1600	
21. viii.	0.2952	0.1545	
22. viii.	0.2800	0.1380	
23. viii.	0.2800	0.1500	
24. viii.	0.3128	0.1500	
25. viii.	0.2900	0.1428	
26. viii.	0.2837	0.1500	
27. viii.	0.2800		
28. viii.	0.3000		
29. viii.	0.2540		
30. viii.	0.2325		

Table 95. Growth in weight of *Phraortes kumamotoensis* in larval period.

Date	No. 24	Date	No. 25	No. 26	No. 27	No. 28
1. vii.	0.2000	19. vi.			0.1500	
2. vii.	0.2434	20. vi.	0.0914	0.0854	0.1667	0.0892
3. vii.	0.2300	21. vi.	0.0842	0.0773	0.1632	0.0888
4. vii.	0.2125	22. vi.	0.0821	0.0725	0.1557	0.0825
5. vii.	0.3295	23. vi.	0.1046	0.0890	0.1990	0.1130
6. vii.	0.2850	24. vi.	0.0980	0.0800	0.1778	0.1040
7. vii.	0.2600	25. vi.	0.0900	0.0750	0.1650	0.1000
8. vii.	0.3520	26. vi.	0.1140	0.0978	0.1979	0.1228
9. vii.	0.2920	27. vi.	0.1000	0.0900	0.1740	0.1100
10. vii.	0.2643	28. vi.	0.0900	0.0870	0.1577	0.1020
11. vii.	0.3075	29. vi.	0.1262	0.1102	0.2020	0.1310
12. vii.	0.2855	30. vi.	0.1079	0.0959	0.1749	0.1048
13. vii.	0.2664	1. vii.	0.1000	0.0900	0.1600	0.0972
14. vii.	0.3650	2. vii.	0.1334	0.1170	0.2200	

15. vii.	0.3230	3. vii.	0.1182	0.0956	0.2190
16. vii.	0.2900	4. vii.	0.1030	0.0894	0.1700
17. vii.	0.3861	5. vii.	0.1440	0.1135	0.2100
18. vii.	0.3298	6. vii.	0.1240	0.0970	0.1735
19. vii.	0.2920	7. vii.	0.1131	0.0868	0.1625
20. vii.	0.3355	8. vii.	0.1520	0.1030	0.2100
21. vii.	0.3018	9. vii.	0.1240	0.0864	0.1800
22. vii.	0.2800	10. vii.	0.1135	0.0800	0.1678
23. vii.	0.3740	11. vii.	0.1590	0.0820	0.2030
24. vii.	0.3500	12. vii.	0.1345		0.1700
25. vii.	0.3260	13. vii.	0.1265		0.1590
26. vii.	0.3810	14. vii.	0.1700		0.1900
27. vii.	0.3500	15. vii.	0.1540		0.1745
28. vii.	0.3000	16. vii.	0.1400		0.1600
29. vii.	0.3450	17. vii.	0.1660		0.2259
30. vii.	0.3100	18. vii.	0.1547		0.2025
31. vii.	0.2855	19. vii.	0.1400		0.1800
1. viii.	0.3400	20. vii.	0.1855		0.2200
2. viii.	0.2925	21. vii.	0.1650		0.1900
3. viii.	0.2674	22. vii.	0.1500		0.1738
4. viii.	0.3140	23. vii.	0.2070		0.1950
5. viii.	0.2853	24. vii.	0.1870		0.1768
6. viii.	0.2743	25. vii.	0.1790		0.1590
7. viii.	0.3182	26. vii.	0.2247		0.1900
8. viii.	0.2975	27. vii.	0.1957		0.1700
9. viii.		28. vii.	0.1600		0.1400
10. viii.		29. vii.	0.2060		0.1600
11. viii.		30. vii.	0.1812		0.1400
12. viii.		31. vii.	0.1718		
13. viii.		1. viii.	0.2234		
14. viii.		2. viii.	0.1866		
15. viii.		3. viii.	0.1830		
16. viii.		4. viii.	0.2390		
17. viii.		5. viii.	0.2130		
18. viii.		6. viii.	0.1970		
19. viii.		7. viii.	0.2500		
20. viii.		8. viii.	0.2300		
21. viii.		9. viii.	0.2084		
22. viii.		10. viii.	0.2390		

Table 96. Amount of leaves eaten by *Phaortes kumamotoensis* in larval period. No. 19.

Date	V	O	W	Date	V	O	W
17. vi.	0.0	0	0	1. vii.	545.5	3764	5019
18. vi.	0.0	0	0	2. vii.	0.0	0	0
19. vi.	151.7	1047	1396	3. vii.	257.5	1777	2369
20. vi.	0.0	0	0	4. vii.	0.0	0	0
21. vi.	200.9	1448	1931	5. vii.	322.7	2227	2969
22. vi.	0.0	0	0	6. vii.	0.0	0	0
23. vi.	223.0	1539	2052	7. vii.	526.0	3698	4931
24. vi.	0.0	0	0	8. vii.	0.0	0	0
25. vi.	0.0	0	0	9. vii.	528.4	3646	4861
26. vi.	0.0	0	0	10. vii.	0.0	0	0
27. vi.	302.0	2084	2778	11. vii.	570.7	3930	5250
28. vi.	0.0	0	0	12. vii.	0.0	0	0
29. vi.	68.0	469	626	13. vii.	369.8	2552	3402
30. vi.	0.0	0	0				

Table 97. The same as above. No. 20.

Date	V	O	W	Date	V	O	W
17. vi.	82.0	566	754	26. vi.	0.0	0	0
18. vi.	0.0	0	0	27. vi.	307.5	2122	2829
19. vi.	0.0	0	0	28. vi.	0.0	0	0
20. vi.	0.0	0	0	29. vi.	444.5	3067	4089
21. vi.	142.0	980	1306	30. vi.	0.0	0	0
22. vi.	0.0	0	0	1. vii.	316.9	2187	2915
23. vi.	247.7	1709	2279	2. vii.	0.0	0	0
24. vi.	0.0	0	0	3. vii.	61.2	421	553
25. vi.	0.0	0	0	4. vii.			

Table 98. The same as above. No. 21.

Date	V	O	W	Date	V	O	W
17. vi.	0.0	0	0	5. vii.	447.7	3089	4119
18. vi.	0.0	0	0	6. vii.	0.0	0	0
19. vi.	108.8	751	1001	7. vii.	465.2	3210	4280
20. vi.	0.0	0	0	8. vii.	0.0	0	0
21. vi.	261.5	1804	2406	9. vii.	425.3	2935	3913
22. vi.	0.0	0	0	10. vii.	0.0	0	0
23. vi.	156.8	1082	1443	11. vii.	501.9	3463	4617
24. vi.	0.0	0	0	12. vii.	0.0	0	0
25. vi.	0.0	0	0	13. vii.	422.4	2915	3886
26. vi.	0.0	0	0	14. vii.	0.0	0	0
27. vi.	341.8	2358	3145	15. vii.	421.0	2905	3873
28. vi.	0.0	0	0	16. vii.	0.0	0	0
29. vi.	557.0	3843	5124	17. vii.	738.5	5096	6794
30. vi.	0.0	0	0	18. vii.	0.0	0	0
1. vii.	87.4	603	807	19. vii.	277.5	1915	2553
2. vii.	0.0	0	0	20. vii.	0.0	0	0
3. vii.	410.0	2829	3772	21. vii.	112.5	776	1035
4. vii.	0.0	0	0				

Table 99. The same as above. No. 22.

Date	V	O	W	Date	V	O	W
18. vi.	0.0	0	0	27. vi.	321.2	2216	2955
19. vi.	0.0	0	0	28. vi.	0.0	0	0
20. vi.	0.0	0	0	29. vi.	426.8	2945	3927
21. vi.	157.5	1087	1449	30. vi.	0.0	0	0
22. vi.	0.0	0	0	1. vii.	318.1	2195	2927
23. vi.	182.7	1261	1681	2. vii.	0.0	0	0
24. vi.	0.0	0	0	3. vii.	183.3	1265	1686
25. vi.	0.0	0	0	4. vii.	0.0	0	0
26. vi.	0.0	0	0	5. vii.	69.5	476	689

Table 100. The same as above. No. 23.

Date	V	O	W	Date	V	O	W
17. vi.	0.0	0	0	29. vi.	218.0	1504	2006
18. vi.	0.0	0	0	30. vi.	0.0	0	0
19. vi.	0.0	0	0	1. vii.	249.2	1719	2293
20. vi.	0.0	0	0	2. vii.	0.0	0	0
21. vi.	39.1	270	360	3. vii.	198.3	1368	1824
22. vi.	0.0	0	0	4. vii.	0.0	0	0
23. vi.	91.8	633	845	5. vii.	227.1	1567	2089
24. vi.	0.0	0	0	6. vii.	0.0	0	0
25. vi.	0.0	0	0	7. vii.	61.8	426	569
26. vi.	0.0	0	0	8. vii.	0.0	0	0
27. vi.	228.0	1573	2098	9. vii.	0.0	0	0
28. vi.	0.0	0	0				

Table 101. Amount of leaves eaten by *Phraortes kumamotoensis* in larval period. No. 24.

Date	V	O	W	Date	V	O	W
1. vii.	0.0	0	0	13. vii.	0.0	0	0
2. vii.	311.0	2146	2861	14. vii.	403.0	2781	3708
3. vii.	0.0	0	0	15. vii.	0.0	0	0
4. vii.	0.0	0	0	16. vii.	0.0	0	0
5. vii.	441.8	3048	4065	17. vii.	580.5	4005	5341
6. vii.	0.0	0	0	18. vii.	0.0	0	0
7. vii.	0.0	0	0	19. vii.	0.0	0	0
8. vii.	587.0	4050	5400	20. vii.	247.2	1706	2274
9. vii.	0.0	0	0	21. vii.	0.0	0	0
10. vii.	0.0	0	0	22. vii.	0.0	0	0
11. vii.	284.0	1960	2613	23. vii.	368.0	2539	3386
12. vii.	0.0	0	0				

Table 102. The same as above. No. 25.

Date	V	O	W	Date	V	O	W
17. vi.	0.0	0	0	6. vii.	0.0	0	0
18. vi.	0.0	0	0	7. vii.	0.0	0	0
19. vi.	0.0	0	0	8. vii.	253.0	1746	2328
20. vi.	25.0	173	230	9. vii.	0.0	0	0
21. vi.	0.0	0	0	10. vii.	0.0	0	0
22. vi.	0.0	0	0	11. vii.	259.0	1787	2383
23. vi.	185.2	1278	1704	12. vii.	0.0	0	0
24. vi.	0.0	0	0	13. vii.	0.0	0	0
25. vi.	0.0	0	0	14. vii.	258.0	1780	2374
26. vi.	195.0	1346	1794	15. vii.	0.0	0	0
27. vi.	0.0	0	0	16. vii.	0.0	0	0
28. vi.	0.0	0	0	17. vii.	170.0	1173	1564
29. vi.	248.0	1711	2282	18. vii.	0.0	0	0
30. vi.	0.0	0	0	19. vii.	0.0	0	0
1. vii.	0.0	0	0	20. vii.	165.0	1139	1518
2. vii.	291.0	2008	2677	21. vii.	0.0	0	0
3. vii.	0.0	0	0	22. vii.	0.0	0	0
4. vii.	0.0	0	0	23. vii.	287.0	1980	2640
5. vii.	207.3	1330	1907				

Table 103. The same as above. No. 26.

Date	V	O	W	Date	V	O	W
17. vi.	31.0	214	285	30. vi.	0.0	0	0
18. vi.	0.0	0	0	1. vii.	0.0	0	0
19. vi.	0.0	0	0	2. vii.	179.1	1236	1648
20. vi.	0.0	0	0	3. vii.	0.0	0	0
21. vi.	0.0	0	0	4. vii.	0.0	0	0
22. vi.	0.0	0	0	5. vii.	112.0	773	1030
23. vi.	94.0	649	865	6. vii.	0.0	0	0
24. vi.	0.0	0	0	7. vii.	0.0	0	0
25. vi.	0.0	0	0	8. vii.	101.0	697	929
26. vi.	114.9	793	1057	9. vii.	0.0	0	0
27. vi.	0.0	0	0	10. vii.	0.0	0	0
28. vi.	0.0	0	0	11. vii.	21.0	145	193
29. vi.	265.0	1829	2438				

Table 104. The same as above. No. 27.

Date	V	O	W	Date	V	O	W
17. vi.	0.0	0	0	6. vii.	0.0	0	0
18. vi.	0.0	0	0	7. vii.	0.0	0	0
19. vi.	0.0	0	0	8. vii.	237.0	1635	2180
20. vi.	157.0	1083	1444	9. vii.	0.0	0	0
21. vi.	0.0	0	0	10. vii.	0.0	0	0
22. vi.	0.0	0	0	11. vii.	209.7	1447	1929
23. vi.	346.0	2387	3183	12. vii.	0.0	0	0
24. vi.	0.0	0	0	13. vii.	0.0	0	0
25. vi.	0.0	0	0	14. vii.	232.0	1601	2134
26. vi.	231.3	1596	2128	15. vii.	0.0	0	0
27. vi.	0.0	0	0	16. vii.	0.0	0	0
28. vi.	0.0	0	0	17. vii.	303.4	2093	2791
29. vi.	404.2	2789	3719	18. vii.	0.0	0	0
30. vi.	0.0	0	0	19. vii.	0.0	0	0
1. vii.	0.0	0	0	20. vii.	152.7	1054	1405
2. vii.	302.2	2085	2780	21. vii.	0.0	0	0
3. vii.	0.0	0	0	22. vii.	0.0	0	0
4. vii.	0.0	0	0	23. vii.	271.3	1872	2496
5. vii.	244.0	1684	2245				

Table 105. The same as above. No. 28.

Date	V	O	W	Date	V	O	W
17. vi.	65.0	449	598	25. vi.	0.0	0	0
18. vi.	0.0	0	0	26. vi.	167.5	1156	1541
19. vi.	0.0	0	0	27. vi.	0.0	0	0
20. vi.	10.0	69	92	28. vi.	0.0	0	0
21. vi.	0.0	0	0	29. vi.	170.0	1173	1564
22. vi.	0.0	0	0	30. vi.	0.0	0	0
23. vi.	146.6	1012	1349				
24. vi.	0.0	0	0				

Table 106. Amount of leaves eaten by *Phraortes kumamotoensis* in larval period. No. 29.

Date	V	O	W	Date	V	O	W
17. vi.	0.0	0	0	27. vi.	40.0	200	248
18. vi.	76.5	383	474	28. vi.	499.0	2495	3094
19. vi.	144.8	724	898	29. vi.	752.0	3760	4662
20. vi.	256.0	1280	1587	30. vi.	444.0	2220	2753
21. vi.	187.0	935	1159	1. vii.			
22. vi.	258.0	1290	1600	2. vii.	920.0	4600	5704
23. vi.	209.0	1045	1296	3. vii.	631.5	3158	3915
24. vi.	295.3	1477	1831	4. vii.	396.0	1980	2455
25. vi.	232.0	1160	1438	5. vii.	629.4	3147	3902
26. vi.	208.3	1046	1291	6. vii.	0.0	0	0

Table 107. The same as above. No. 30.

Date	V	O	W	Date	V	O	W
17. vi.	0.0	0	0	27. vi.	61.0	305	378
18. vi.	33.0	165	205	28. vi.	118.0	590	732
19. vi.	197.2	986	1223	29. vi.	525.0	2625	3255
20. vi.	175.0	875	1085	30. vi.	790.0	3950	4898
21. vi.	274.5	1373	1702	1. vii.	385.9	1930	2393
22. vi.	174.0	870	1079	2. vii.	638.0	3190	3956
23. vi.	289.5	1448	1795	3. vii.	1042.0	5210	6460
24. vi.	422.7	2114	2621	4. vii.	758.7	3794	4704
25. vi.	325.0	1625	2015	5. vii.	283.0	1415	1755
26. vi.	343.5	1718	2130	6. vii.	0.0	0	0

Table 108. The same as above. No. 31.

Date	V	O	W	Date	V	O	W
16. vi.	6.0	30	37	25. vi.	276.0	1380	1711
17. vi.	122.5	623	760	26. vi.	0.0	0	0
18. vi.	235.2	1176	1458	27. vi.	180.3	902	1118
19. vi.	246.5	1233	1528	28. vi.	602.0	3010	3732
20. vi.	196.1	981	1216	29. vi.	609.4	3047	3778
21. vi.	257.5	1288	1597	30. vi.	1211.0	6055	7508
22. vi.	323.5	1618	2006	1. vii.	784.0	3920	4861
23. vi.	294.3	1472	1855	2. vii.	1094.0	5470	6783
24. vi.	369.0	1845	2288	3. vii.	323.8	1619	2008
				4. vii.	0.0	0	0

Table 109. The same as above. No. 32.

Date	V	O	W	Date	V	O	W
16. vi.	91.0	458	564	25. vi.	199.0	995	1234
17. vi.	105.0	525	651	26. vi.	256.0	1280	1587
18. vi.	89.5	448	555	27. vi.	329.5	1648	2043
19. vi.	62.0	310	384	28. vi.	260.0	1300	1612
20. vi.	49.0	245	304	29. vi.	242.2	1211	1502
21. vi.	0.0	0	0	30. vi.	101.4	507	629
22. vi.	0.0	0	0	1. vii.	209.5	1048	1299
23. vi.	106.0	530	657	2. vii.	0.0	0	0
24. vi.	123.9	620	769	3. vii.	0.0	0	0

Table 110. The same as above. No. 33.

Date	V	O	W	Date	V	O	W
19. vi.	0.0	0	0	27. vi.	248.8	1244	1543
20. vi.	64.0	320	397	28. vi.	295.0	1475	1829
21. vi.	84.1	421	521	29. vi.	256.4	1282	1590
22. vi.	157.3	787	975	30. vi.	322.5	1613	2000
23. vi.	218.7	1094	1356	1. vii.	167.8	839	1040
24. vi.	169.0	845	1048	2. vii.	0.0	0	0
25. vi.	167.6	838	1039	3. vii.	0.0	0	0
26. vi.	282.5	1413	1752				

Table 111. Amount of leaves eaten by *Phraortes kumamotoensis* in larval period. No. 34.

Date	V	O	W	Date	V	O	W
21. vi.	210.9	1455	1940	26. vi.	0.0	00	00
22. vi.	0.0	0	0	27. vi.	0.0	0	0
23. vi.	0.0	0	0	28. vi.	0.0	0	0
24. vi.	0.0	0	0	29. vi.	0.0	0	0
25. vi.	0.0	0	0	30. vi.	190.8	1317	1755

Table 112. The same as above. No. 37.

Date	V	O	W	Date	V	O	W
21. vi.	155.8	1075	1433	26. vi.	0.0	0	0
22. vi.	0.0	0	0	27. vi.	0.0	0	0
23. vi.	0.0	0	0	28. vi.	0.0	0	0
24. vi.	0.0	0	0	29. vi.	0.0	0	0
25. vi.	0.0	0	0	30. vi.	48.5	335	446

Table 113. The same as above. No. 38.

Date	V	O	W	Date	V	O	W
21. vi.	235.0	1622	2162	26. vi.	0.0	0	0
22. vi.	0.0	0	0	27. vi.	0.0	0	0
23. vi.	0.0	0	0	28. vi.	0.0	0	0
24. vi.	0.0	0	0	29. vi.	0.0	0	0
25. vi.	0.0	0	0	30. vi.	187.0	1290	1720

Table 114. Amount of leaves eaten by *Phraortes kumamotoensis* in larval period. No. 39.

Date	V	O	W	Date	V	O	W
18. vi.	31.0	214	285	10. vii.	73.0	504	672
19. vi.	41.0	283	387	11. vii.	77.0	531	702
20. vi.	34.5	238	317	12. vii.	69.0	476	635
21. vi.	36.0	248	331	13. vii.	91.0	628	837
22. vi.	86.0	593	791	14. vii.	89.0	614	819
23. vi.	69.0	476	639	15. vii.	78.0	538	718
24. vi.	68.0	469	626	16. vii.	132.0	911	1214
25. vi.	54.0	373	497	17. vii.	78.0	538	718
26. vi.	86.0	593	791	18. vii.	115.0	796	1058
27. vi.	88.0	607	810	19. vii.	88.0	607	810
28. vi.	85.0	587	782	20. vii.	77.0	531	708
29. vi.	226.0	1559	2079	21. vii.	65.0	449	598
30. vi.	0.0	0	0	22. vii.	102.0	704	938
1. vii.	60.0	414	552	23. vii.	73.0	504	672
2. vii.	76.0	724	699	24. vii.	137.0	945	1260
3. vii.	73.0	504	672				
4. vii.	0.0	0	0				
5. vii.	30.0	207	276				
6. vii.							
7. vii.	73.0	504	672				
8. vii.	76.0	524	699				
9. vii.	61.0	421	561				

Table 115. The same as above. No. 40.

Date	V	O	W	Date	V	O	W
18. vi.	23.0	158	212	7. vii.	63.5	435	580
19. vi.	25.8	178	237	8. vii.	42.0	290	386
20. vi.	30.0	207	276	9. vii.	26.0	179	239
21. vi.	76.5	528	704	10. vii.	28.0	193	258
22. vi.	58.0	400	534	11. vii.	23.0	159	212
23. vi.	55.0	380	506	12. vii.	23.0	159	212
24. vi.	50.0	345	460	13. vii.	33.0	228	304
25. vi.	36.0	248	331	14. vii.	28.0	193	258
26. vi.	31.0	214	285	15. vii.	44.0	304	405
27. vi.	65.9	449	598	16. vii.	39.0	269	359
28. vi.	42.0	290	386	17. vii.	38.0	262	350
29. vi.	169.0	1166	1555	18. vii.	54.0	373	499
30. vi.	0.0	0	0	19. vii.	44.0	304	405
1. vii.	36.0	248	331	20. vii.	27.0	186	248
2. vii.	62.0	428	570	21. vii.	58.0	400	534
3. vii.	65.0	449	598	22. vii.	42.0	290	386
4. vii.	40.0	276	368	23. vii.	36.0	248	331
5. vii.	62.0	428	570	24. vii.	70.0	483	644
6. vii.	58.0	400	534				

Table 116. The same as above. No. 41.

Date	V	O	W	Date	V	O	W
18. vi.	15.0	104	138	30. vi.	0.0	0	0
19. vi.				1. vii.	65.0	450	608
20. vi.	15.0	104	138	2. vii.	117.0	807	1076
21. vi.	61.0	421	561	3. vii.	95.0	656	874
22. vi.	35.0	242	322	4. vii.	75.0	518	690
23. vi.	42.0	290	386	5. vii.	79.0	545	727
24. vi.	51.0	352	469	6. vii.	82.0	566	754
25. vi.	47.0	324	432	7. vii.	79.0	545	727
26. vi.	77.0	531	708	8. vii.	72.0	497	662
27. vi.	69.0	476	634	9. vii.	73.0	504	672
28. vi.	66.0	455	607	10. vii.	50.0	345	460
29. vi.	187.0	1290	1720	11. vii.	0.0	0	0

Table 117. The same as above. No. 43.

Date	V	O	W	Date	V	O	W
18. vi.	11.5	79	106	5. vii.	38.0	262	350
19. vi.	28.0	193	258	6. vii.	40.0	276	368
20. vi.	22.8	157	210	7. vii.	117.0	807	1076
21. vi.	56.0	386	515	8. vii.	72.0	497	662
22. vi.	0.0	0	0	9. vii.	128.0	883	1178
23. vi.	0.0	0	0	10. vii.	37.0	255	340
24. vi.	81.5	562	750	11. vii.	43.0	297	350
25. vi.	18.0	124	166	12. vii.	29.0	200	267
26. vi.	14.0	97	129	13. vii.	42.0	290	386
27. vi.	51.0	352	469	14. vii.	43.0	297	396
28. vi.	102.0	704	938	15. vii.	46.0	317	422
29. vi.	111.0	766	1021	16. vii.	50.0	345	460
30. vi.	0.0	0	0	17. vii.	25.0	173	230
1. vii.	31.5	217	290	18. vii.	49.0	338	451
2. vii.	18.0	124	166	19. vii.	50.0	345	460
3. vii.	45.0	318	414	20. vii.	39.0	269	359
4. vii.	43.0	297	396				

Table 118. The same as above. No. 42.

Date	V	O	W	Date	V	O	W
18. vi.	25.0	153	230	30. vi.	0.0	0	0
19. vi.	37.0	255	340	1. vii.	47.0	324	432
20. vi.	51.0	352	469	2. vii.	73.0	504	672
21. vi.	0.0	0	0	3. vii.	71.5	493	658
22. vi.	80.0	552	736	4. vii.	47.0	324	432
23. vi.	43.0	297	396	5. vii.	123.0	849	1132
24. vi.	91.0	628	837	6. vii.	363.0	2505	3340
25. vi.	62.0	428	570	7. vii.	70.0	483	644
26. vi.	65.0	449	598	8. vii.	108.0	745	994
27. vi.	73.5	507	676	9. vii.	86.0	593	791
28. vi.	63.0	435	580	10. vii.	69.0	478	635
29. vi.	182.0	1256	1674	11. vii.	0.0	0	0

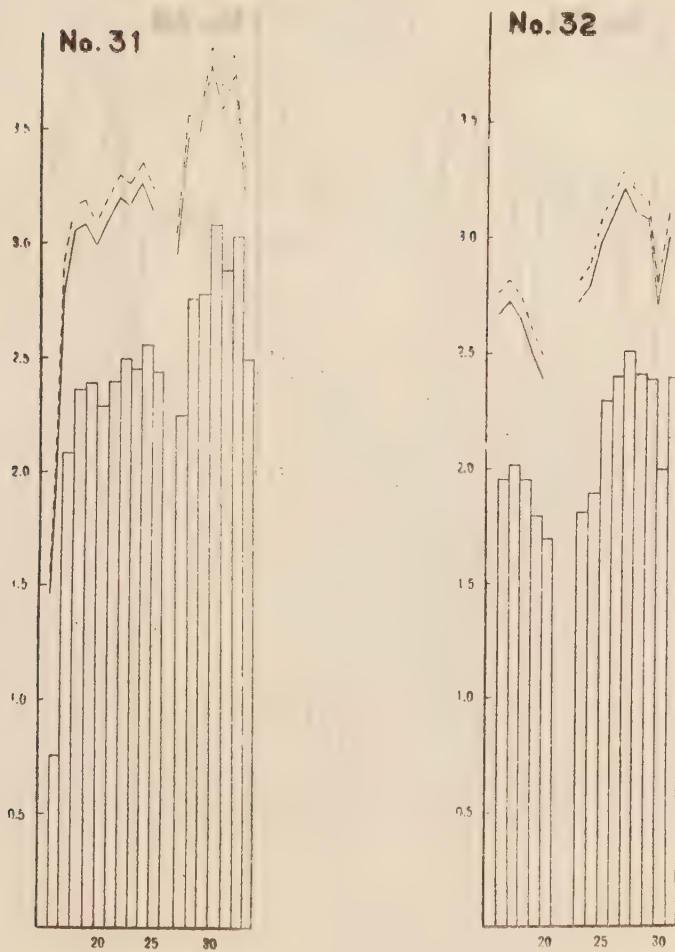
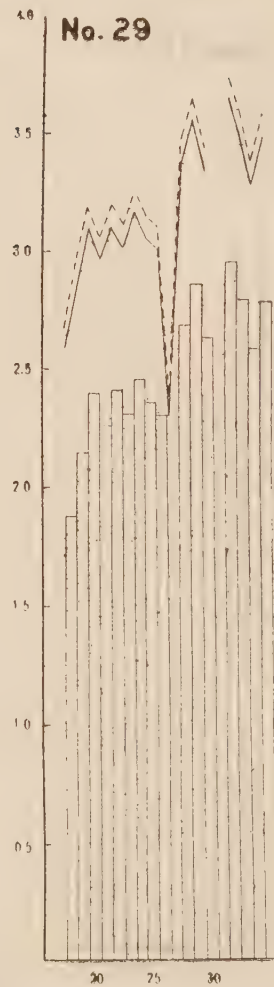
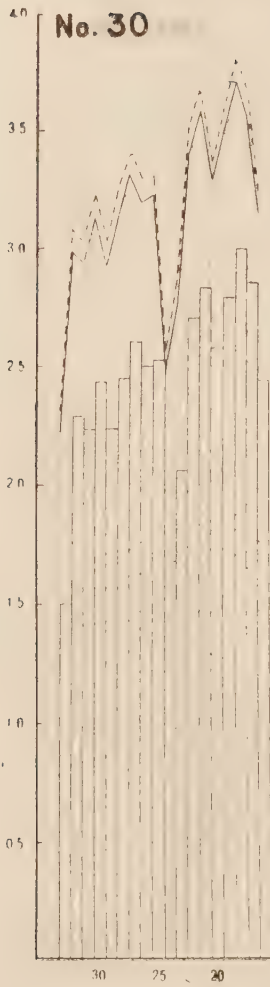
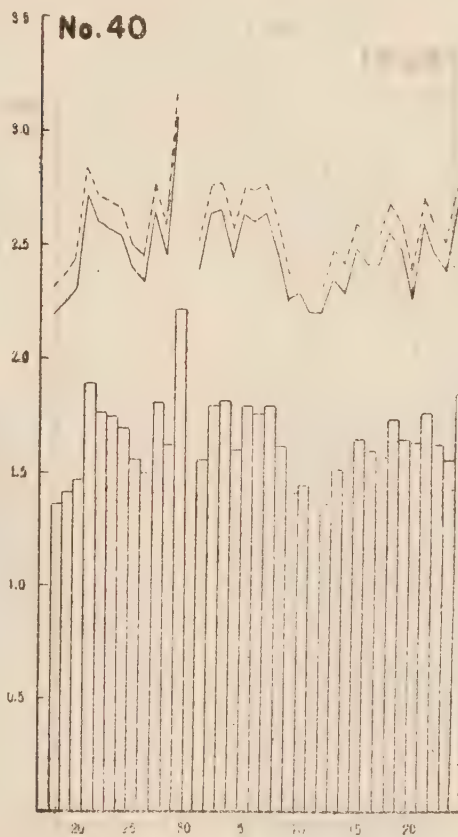
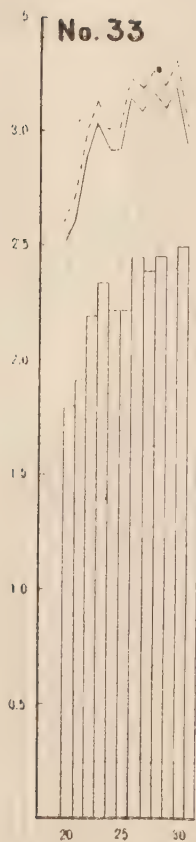
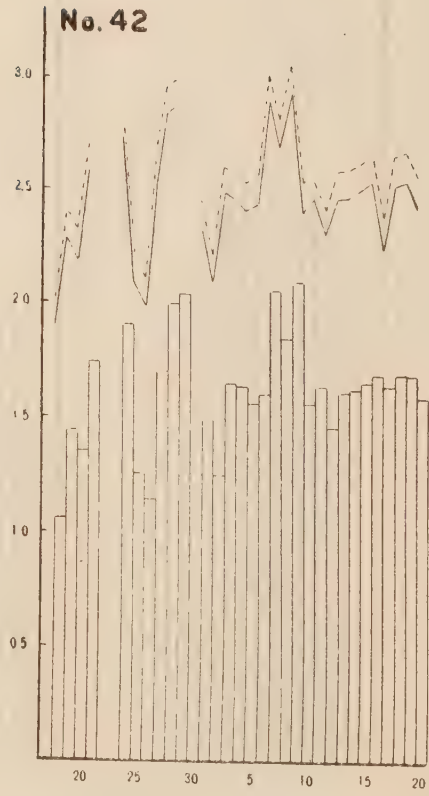
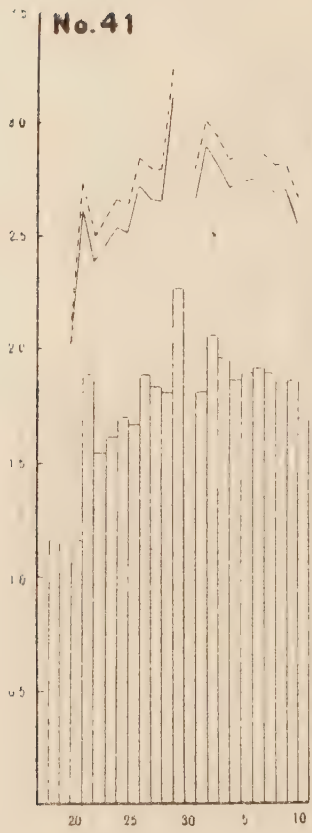
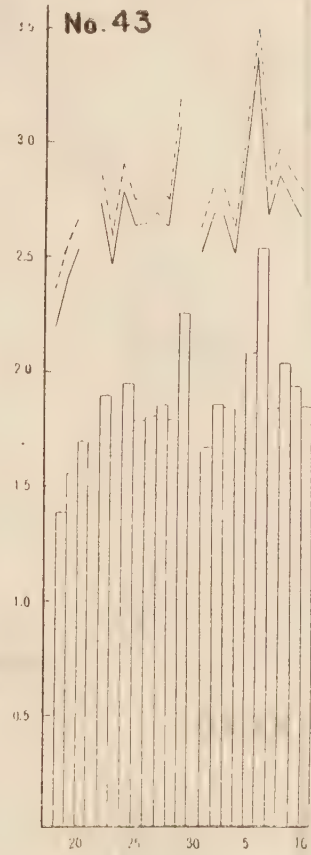
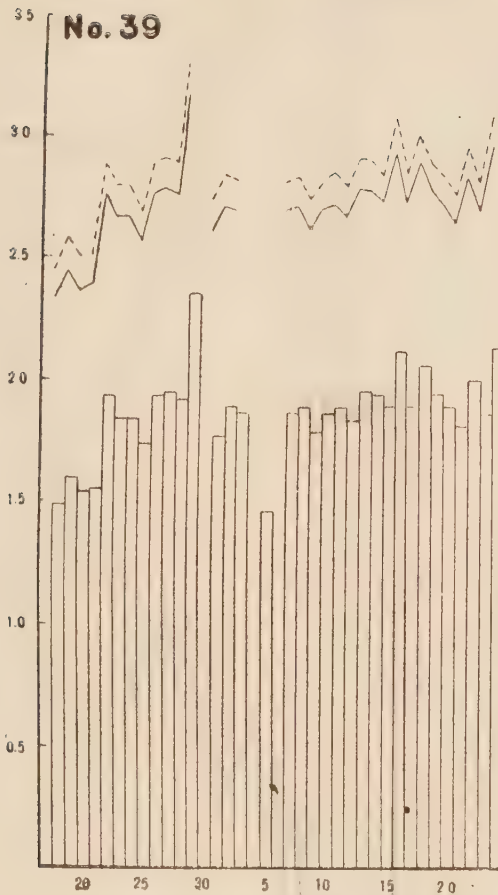


Fig. 34. Amount of leaves eaten by *Phraortes kumamotoensis* during the larval stadia. Abscissa represents time in date from June to July.









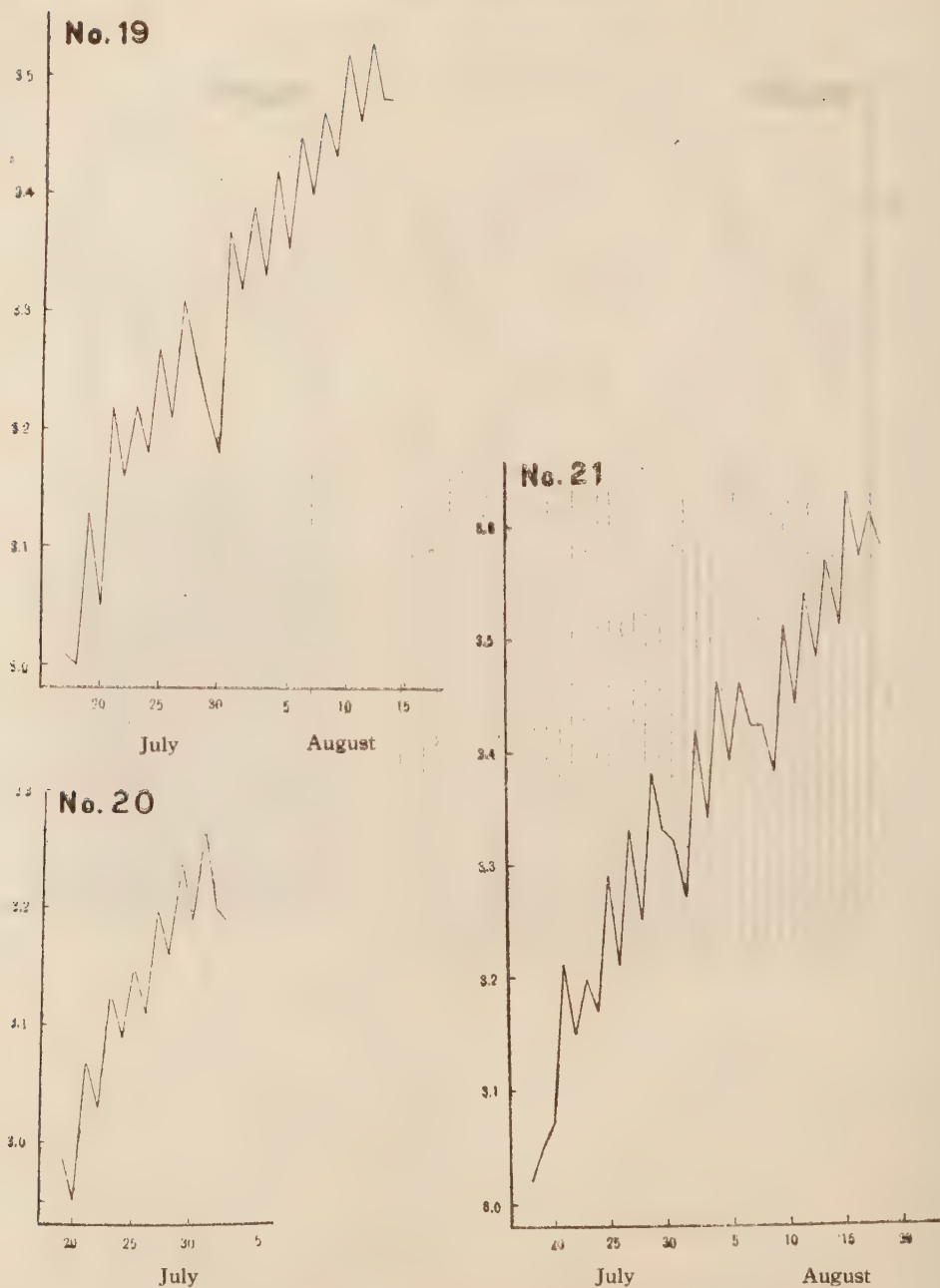
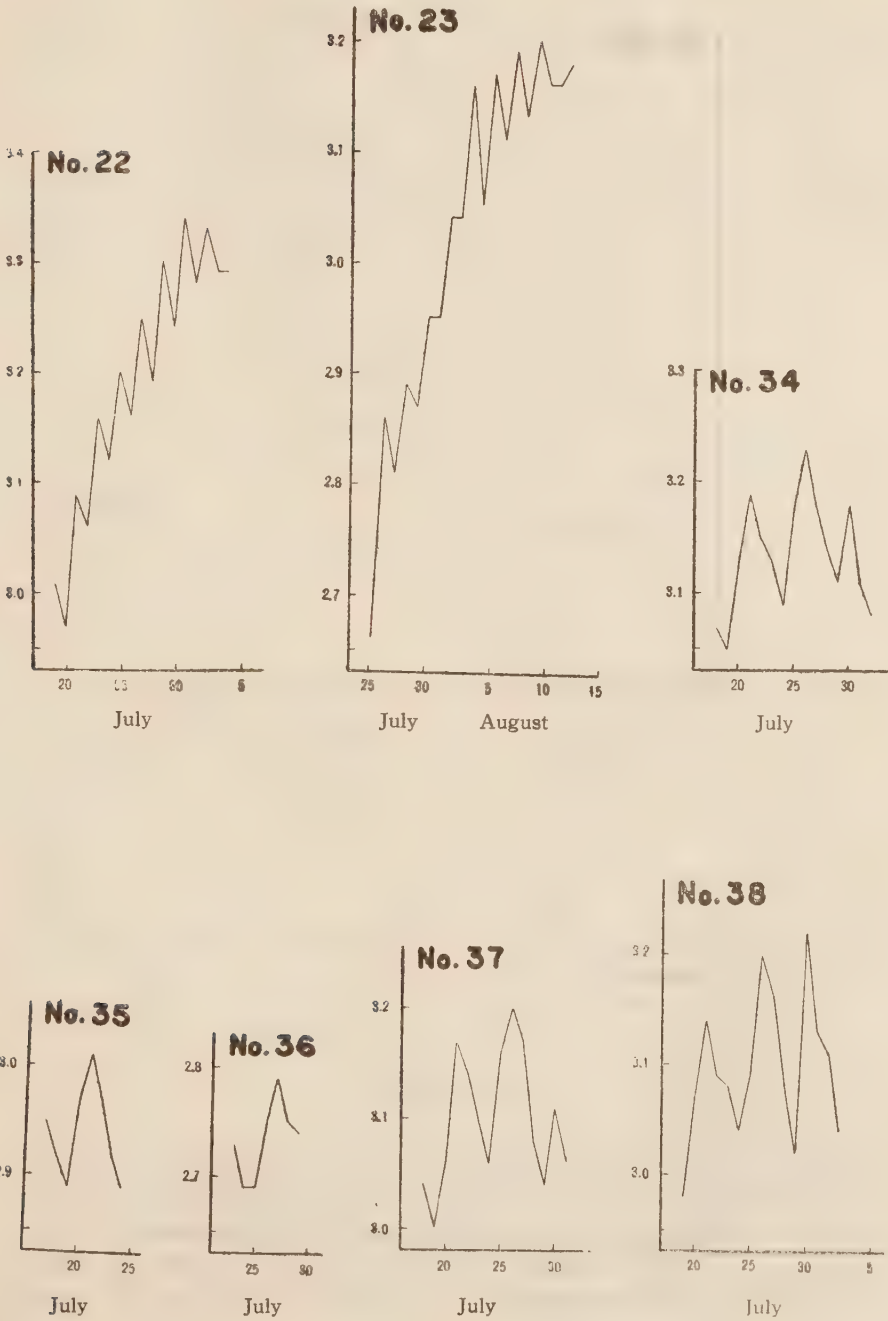
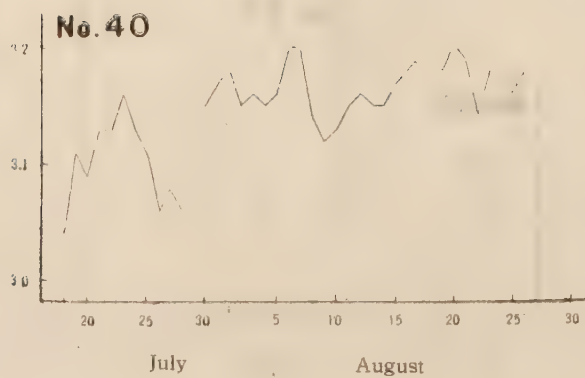
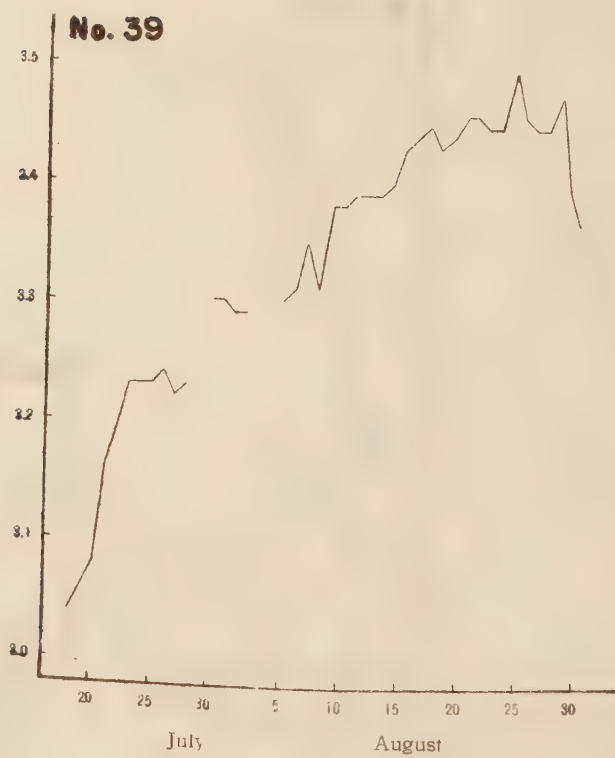
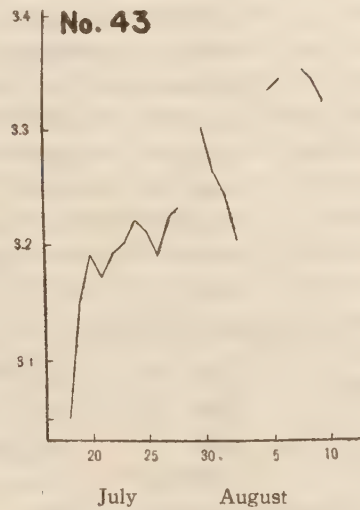
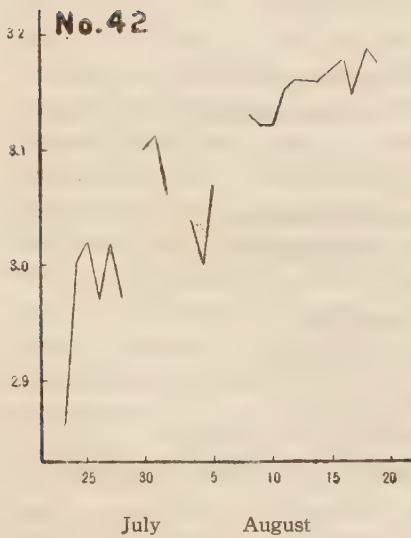
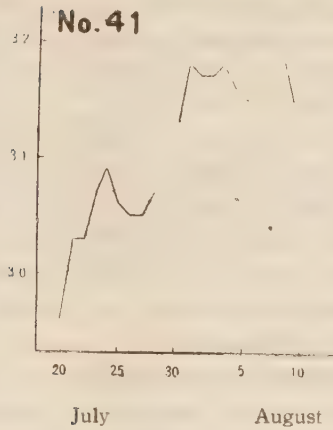


Fig. 35. Change in weight of *Phraortes kumamotoensis* during the larval stadia. Abscissa represents time in days. Ordinate indicates the logarithm of the body weight.







4. Experiments Series 4

In the Experiments Classes 8, 9 and 10, the relation between the food consumption and the oviposition was investigated. The insects belonging to the Class 8 were fed on the foliage of *Lyonia Neziki* on every other day, those belonging to the Class 9 were fed on *Lyonia Neziki* once a day, and the insects Class 10 were

fed on the same plant on every second day. The number and the size of the deposited eggs, the body weight of the insects and the amount of food consumed by the insects were carefully observed every day up to the time of their death.

The general shape of the egg of this Phasmid is somewhat similar to a flattened cask (capsule), flat at one pole and hemispherical at the other, and having an oval cross-section. The flat end is covered by a lid, which consists of a platform or operculum with an encircling ridge, and in the middle of it there is a slight buff-coloured glossy cap or capitulum. On one side of the capsule, there is a mark of ovary attachment.

Concerning the external morphology of the egg of *Phraortes kumamotoensis*, I have already shown the following facts in my previous paper (1931). In that study the following parts of the egg were measured.

- a : Length of the capsule.
- b : Width of the capsule laid in natural condition.
- c : Thickness of the capsule (b is perpendicular to c, $b > c$).
- d : Length of the operculum.
- e : Width of the operculum ($d > e$).
- f : Length of the mark of ovary attachment.
- g : Width of the mark of ovary attachment.
- h : Diameter of the capitulum.
- i : Length (or height) of the capitulum.

The following notations were used in this study.

- : Egg with a capitulum normal.
- △ : Egg with a capitulum moderately deformed.
- × : Egg with a capitulum strongly deformed or without a capitulum.

From the results of these measurements the following relations were obtained.

1. $a : b = a : f$.
2. $b : c = d : e$.
3. The form of the capitulum shows a comparatively wide range of variation. Among 282 eggs examined ○ was the most predominant type, occupying 68 per cent, △ took the value of 13 per cent, and × occupied 19 per cent.
4. The form of the capitulum or the absence of the capitulum

is independent of the growth of the embryo within the egg, if the egg was laid by a sound female insect.

5. In general the eggs with a deformed capitulum are deposited by ill-fed females.

6. The shape of the capsule has a close connection with the hatching of the egg, even when the embryo within itself has completed its entire development. Indeed no larvae can hatch out from eggs with a deformed capsule.

Experiments Class 8

No. 44, ♀ An insect, underwent the last moult on July 6th, was taken for experiment immediately after the moult. It was 0.3820 gr. in weight and attained a maximum weight of 0.8055 gr. 22 days later, about 2.1 times its original weight. After a preoviposition period of 12 days the insect dropped a first egg on July 18th, when it weighed 0.5900 gr., about 1.5 times its original weight. As many as 88 eggs were laid by this insect during 64 days, the average number being 1.37 per day. Of these 64 days this insect showed no sign of oviposition on 19 days. The non-ovipositing days were arranged in order as follows: 1-1-1-1-1-1-1-1-2-1-1-1-6. On August 1st the insect dropped 6 eggs, the maximum value of oviposition per day in this female during her life. The shapes of the capitulum of eggs were: ○-4 eggs (4.5%) △-55 eggs (62.5%), ×-29 eggs (33.0%). This insect died 75 days after being placed on this experiment. The length of the mesothorax was 16.6 mm, and the dry weight of the same portion was 0.0150 gr.

No. 45, ♀ An insect, underwent the final moult on July 9th, was put then immediately on this experiment. It was 0.3000 gr. in weight and reached a maximum weight of 0.5460 gr. as late as 48 days after, about 1.5 times its original weight. After a pre-oviposition period of 12 days, this insect laid a first egg on July 21st, when it weighed 0.3800 gr., about 1.3 times its original weight. The total number of eggs laid by this insect was 34 during 45 days, the average number being 0.75 per day. On 20 days this insect laid no eggs. The non-ovipositing days were given in order

as follows: 1-1-2-1-1-1-1-1-3-4-1-2-1. On August 14th the insect exhibited the maximum record of oviposition, laying 3 eggs, during her life. The shapes of the capitulum of eggs showed: ○-8 eggs (23.5%), △-22 eggs (64.7%), ×-4 eggs (11.8%). The duration of life under experimental condition of this insect was 60 days. The length of the mesothorax was 15.0 mm, and the dry weight of the same portion took the value of 0.0100 gr.

No. 46, ♀ An insect, underwent the last moult on July 7th, was used immediately in this experiment. It was 0.5225 gr. in weight and attained a maximum weight of 0.9900 gr., or about 1.8 times its original weight, at an age of 20 days after the last moult, on July 26th. After a preoviposition period of 10 days, this insect dropped a first egg on July 17th, when it weighed 0.7500 gr., about 1.4 times its original weight. This insect laid 84 eggs during 41 days, the average number of eggs being 2.05 per day. On about 5 days this insect laid no eggs. The non-ovipositing days are given in order as follows: 1-1-1-1-1. On August 14th this insect exhibited the highest record of laying 6 eggs during her life. The shapes of the capitulum of eggs presented: ○-17 eggs (20.2%), △-66 eggs (78.6%), ×-1 egg (1.2%). The duration of life in adult insect was 74 days. The mesothorax was 16.7 mm in length and 0.0166 gr. in dry weight.

No. 47, ♀ An insect, underwent the final moult on July 7th, was then immediately transferred to this experiment. It was 0.4225 gr. in weight and attained a maximum weight of 0.7800 gr., or about 1.8 times its original weight, at an age of 20 days after the last moult, on July 26th. After a preoviposition period of 12 days this insect laid a first egg on July 19th, when it weighed 0.6181 gr., about 1.4 times its original weight. This insect deposited 59 eggs during 61 days, the average number of eggs being 0.96 per day. On 25 days this insect laid no eggs. The non-ovipositing days were arranged in order as follows: 1-1-1-1-1-1-1-1-2-1-4-1-3-1-4. On August 7th this insect made the highest record of laying 4 eggs per day during her life. The shapes of the capitulum of eggs were: ○-25 eggs (42.4%), △-26 eggs (44.1%), ×-8 eggs (13.5%). This adult female lived 74 days. The mesothorax was 16.0 mm in length and 0.0126 gr. in dry weight.

No. 48, ♀ An insect, underwent the final moult on July 7th,

was used in this experiment immediately after the moult. It was 0.4890 gr. in weight and attained a maximum weight of 0.8240 gr., or about 1.6 times its initial weight, on July 26th. After a period of 12 days the first oviposition took place on July 19th, when it weighed 0.6337 gr., about 1.2 times its initial weight. This insect dropped as many as 60 eggs in 61 days, the average being 0.98 per day. On 30 days this insect laid no eggs. The non-ovipositing days were given in order as follows: 1-1-2-1-1-1-6-8-1-1-6. On August 4th the insect exhibited the highest record of laying 4 eggs per day during her life. The shapes of the capitulum of eggs were: ○-18 eggs (30.0%), △-41 eggs (68.3%), ×-1 egg (1.7%). The duration of life of this adult insect was 74 days. The mesothorax was 16.9 mm in length and 0.0135 gr. in dry weight.

Experiments Class 9

No. 49, ♀ An insect, which underwent the last moult on July 11th, was used immediately after the moult in this experiment. It was 0.4300 gr. in weight and attained a maximum weight of 0.8050 gr., about 1.8 times its original weight, 16 days later. After a pre-oviposition period of 11 days this insect laid a first egg on July 22nd, when it weighed 0.7140 gr., about 1.6 times its initial weight. The duration of life of the adult female was 52 days. The mesothorax was 17.2 mm in length and 0.0150 gr. in dry weight. No further observations were made on this insect.

No. 50, ♀ An insect, underwent the last moult on July 11th, was put then immediately on this experiment. It was then 0.4100 gr. in weight and took a maximum weight of 0.7400 gr., or about 1.8 times its initial weight, as late as 50 days. After a preoviposition period of 16 days, the first oviposition took place on July 27th, when the insect weighed 0.6500 gr., about 1.6 times its initial weight. This insect laid 30 eggs in 55 days, thus the average number of eggs being 0.54 per day. On 34 days this insect laid no eggs. The non-ovipositing days were given in order as follows: 7-3-2-1-5-2-4-1-5-1-1-1-1. On August

24th and September 19th the insect exhibited the maximum record of laying 3 eggs respectively during her life of 70 days. The shapes of the capitulum of eggs were: ○—2 eggs (6.7%), △—28 eggs (93.3%), ×—no eggs. This insect died on September 19th, when its mesothorax was 17.0 mm in length and 0.0145 gr. in dry weight.

No. 51, ♀ An insect, undergone the final moult on July 11th, was put on this experiment immediately after the moult. It was then 0.4570 gr. in weight, and after a very long period of 67 days it attained a maximum weight of 0.8790 gr., or about 1.9 times its original weight. After a long preoviposition period of 16 days this insect laid a first egg on July 27th, when it weighed 0.6500 gr., about 1.4 times its original weight. The total number of eggs dropped by this insect was 43 during 55 days, thus the average being 0.78 eggs per day. On 26 days the insect dropped no eggs. The non-ovipositing days are given in order as follows: 5—7—1—2—1—2—1—1—2—3—1. On September 19th the insect made a highest record of ovipositing 3 eggs during her life of 70 days. The shapes of the capitulum of eggs presented: ○—13 eggs (30.2%), △—22 eggs (51.1%), ×—8 eggs (18.7%). The length of the mesothorax was 17.5 mm and the dry weight of the same portion took the value of 0.0154 gr.

No. 52, ♀ An insect, which underwent the last moult on July 11th, was used then immediately in this experiment. It was at first weighed 0.4338 gr. and attained a maximum weight of 0.7000 gr., or about 1.6 times its original weight, as late as 39 days. After a very long preoviposition period of 18 days this insect laid a first egg, when it weighed 0.5000 gr., about 1.2 times its initial weight. The total number of eggs laid by this insect was 3 during 22 days, thus the average number being 0.14 per day. The first egg with a normal capitulum was dropped on July 29th. The second egg without a capitulum was laid on August 14th. The third egg with a deformed capitulum was dropped on August 19th. The duration of life of this adult female was 54 days. The mesothorax was 17.9 mm in length and 0.0122 gr. in dry weight.

No. 53, ♀ An insect, which underwent the last moult on July 11th, was put then on this experiment. This insect could not with stand hunger longer than 16 days and died on July 27th.

Experiments Class 10

No. 54, ♀ An insect, which underwent the final ecdysis on July 9th, was used then at once in this experiment. It was then 0.3820 gr. in weight and reached a maximum value of 0.7630 gr., or about twice its initial weight, as late as 19 days. After a comparatively long preoviposition period of 15 days this insect laid a first egg on July 24th, when it weighed 0.6560 gr., about 1.7 times its original weight. The total number of eggs laid by this insect was 50 during 41 days, thus the average number of eggs being 1.21 per day. The non-ovipositing days are given in order as follows: 1-2-2-13 (total 18 days). On August 13th the insect acquired the highest record of laying 4 eggs during her life of 56 days. The shapes of the capitulum of eggs were: ○-6 eggs (12.0%), △-41 eggs (82.0%), ×-3 eggs (6.0%). The mesothorax was 16.9 mm in length and 0.0128 gr. in dry weight.

No. 55, ♀ An insect, undergone the final moult on July 12th, was put then at once on this experiment. It was then 0.3900 gr. in weight and attained a maximum weight of 0.8020 gr., or about twice its initial weight, as late as 16 days. After a comparatively shorter period of 10 days this insect laid a first egg on July 22nd, when it weighed 0.6050 gr., about 1.5 times its original weight. The total number of eggs dropped by this insect was 26 during 14 days, thus the average number representing 1.85 per day. The insect continued to drop eggs every day and exhibited a maximum value of laying 4 eggs during her life of 26 days. The shapes of the capitulum of eggs were: ○-12 eggs (46.2%), △-14 eggs (53.8%). The mesothorax was 15.8 mm in length and 0.0123 gr. in dry weight.

No. 56, ♀ An insect, which underwent the last moult on July 13th, was used then at once on this experiment. It was then 0.3530 gr. in weight and attained a maximum weight of 0.7200 gr., or about twice its initial weight, 14 days later. After a preoviposition period of 13 days this insect laid a first egg on July 26th, when it weighed 0.7200 gr. The total number of eggs laid by this insect was 14 during 13 days, thus the average number being 1.07 per day. The non-ovipositing days are given in order as follows: 1-4-1 (total 6 days). On July 27th and 29th this insect exhibited the maximum record of laying 3 eggs respectively dur-

ing her life. The shapes of the capitulum of eggs were: ○—2 eggs (14.4%), △—8 eggs (57.1%), × 4 eggs (28.5%). The duration of life of this adult female was as short as 30 days. The mesothorax was 15.6 mm in length and 0.0125 gr. in dry weight.

No. 57, ♀ An insect, which underwent the final ecdysis on July 13th, was put then immediately on this experiment. It was then 0.4273 gr. in weight and reached a highest value of weight 0.8280 gr., about twice its original weight, as late as 18 days. After a preoviposition period of 10 days the insect dropped a first egg, when it was 0.6625 gr. in weight, about 1.5 times its initial weight. The total number of eggs laid by this insect was 43 during 33 days, the average number representing 1.30 per day. The non-ovipositing days are given in order as follows: 1—5—1—1 (total 8 days). On July 31st the insect dropped 4 eggs which were the highest record of laying eggs in this female. The shapes of the capitulum of eggs were: ○—28 eggs (65.1%), △—11 eggs (25.6%), ×—4 eggs (9.3%). The duration of life of this adult female was as long as 68 days. The mesothorax was 16.0 mm in length and 0.0126 gr. in dry weight.

No. 58, ♀ An insect, which underwent the last moult on July 17th, was used then at once in this experiment. At first it was 0.3470 gr. in weight and attained a maximum weight of 0.5500 gr., about 1.4 times its original weight, after a long period of 15 days. After a preoviposition period of 9 days this insect dropped a first egg on July 26th, when it weighed 0.4500 gr., about 1.3 times its initial weight. The insect laid only 3 eggs during 13 days, thus the average number being 0.23 per day. The non-ovipositing days are given in order as follows: 5—5 (total 10 days). The first egg with a deformed capitulum was laid on July 26th. The second one with a normal capitulum was dropped on August 1st and the third one with a deformed capitulum was laid on August 7th. The duration of life of this adult female was as short as 23 days. The mesothorax measured 17.2 mm in length and 0.0128 gr. in dry weight.

Table 119. Growth in weight of *Phraortes kumamotoensis* in larval and adult stages. (* indicates the date of the first egg dropped.)

Date	No. 44	No. 45	No. 46	No. 47	No. 48
6. vii.	0.3820				
7. vii.	0.4520		0.5225	0.4225	0.4890
8. vii.	0.4157		0.6548	0.4790	0.4820
9. vii.	0.6000	0.3000	0.5750	0.4250	0.4221
10. vii.	0.5250	0.4000	0.6960	0.4990	0.5300
11. vii.	0.6500	0.3420	0.6060	0.4455	0.4600
12. vii.	0.5400	0.4100	0.7640	0.6000	0.5700
13. vii.	0.6590	0.3258	0.6595	0.5043	0.5055
14. vii.	0.5700	0.4240	0.8060	0.6448	0.6449
15. vii.	0.6510	0.3548	0.7099	0.5595	0.5532
16. vii.	0.5700	0.4140	0.8583	0.6788	0.6500
17. vii.	0.6650	0.3435	*0.7500	0.5890	0.6550
18. vii.	*0.5900	0.4600	0.9135	0.7500	0.7135
19. vii.	0.7060	0.3855	0.7716	*0.6181	*0.6337
20. vii.	0.6200	0.4600	0.8825	0.7128	0.7768
21. vii.	0.7400	*0.3800	0.7750	0.6175	0.6674
22. vii.	0.6370	0.4400	0.9200	0.7150	0.7680
23. vii.	0.7825	0.3500	0.7780	0.5953	0.6548
24. vii.	0.6770	0.4568	0.8889	0.7200	0.7800
25. vii.	0.7800	0.3580	0.7880	0.6040	0.6645
26. vii.	0.6860	0.5047	0.9900	0.7800	0.8240
27. vii.	0.8055	0.4000	0.7920	0.6300	0.6980
28. vii.	0.6750	0.4385	0.8570	0.7800	0.7500
29. vii.	0.7300	0.3530	0.7400	0.6530	0.6040
30. vii.	0.6400	0.4598	0.7647	0.6740	0.6595
31. vii.	0.7625	0.3930	0.6875	0.5782	0.5700
1. viii.	0.6400	0.4710	0.8124	0.7100	0.7600
2. viii.	0.7479	0.3849	0.7032	0.6039	0.6278
3. viii.	0.6331	0.4462	0.7883	0.7558	0.6932
4. viii.	0.7785	0.3736	0.7000	0.6204	0.6018
5. viii.	0.6700	0.4271	0.8552	0.7050	0.6789
6. viii.	0.7810	0.3700	0.7500	0.6000	0.5863
7. viii.	0.6368	0.5190	0.8269	0.6790	0.6720
8. viii.	0.7642	0.4465	0.7200	0.5800	0.5858

9.	viii.	0.6440	0.5095	0.8400	0.7300	0.6325
10.	viii.	0.7827	0.4375	0.7134	0.6200	0.5527
11.	viii.	0.6538	0.5273	0.9376	0.7182	0.6500
12.	viii.	0.7447	0.4103	0.7605	0.5703	0.5056
13.	viii.	0.6395	0.4813	0.8621	0.6869	0.6870
14.	viii.	0.6925	0.3982	0.7335	0.5892	0.5768
15.	viii.	0.5898	0.4558	0.7965	0.7384	0.6754
16.	viii.	0.6878	0.3915	0.7795	0.6380	0.5815
17.	viii.	0.6855	0.4864		0.7222	0.6577
18.	viii.	0.7048	0.4036	0.7400	0.5985	0.5324
19.	viii.	0.6080	0.5095	0.9282	0.7243	0.6600
20.	viii.	0.7078	0.4225	0.7600	0.6025	0.5542
21.	viii.	0.5943	0.5165	0.8823	0.7387	0.6788
22.	viii.	0.6913	0.4200	0.7658	0.6263	0.5766
23.	viii.	0.5904	0.5270	0.8857	0.6890	0.6500
24.	viii.	0.7303	0.4330	0.7437	0.5855	0.5330
25.	viii.	0.6138	0.5460	0.8800	0.6600	0.6124
26.	viii.	0.7332	0.4600	0.7500	0.5523	0.5360
27.	viii.	0.6137	0.5350	0.8744	0.7105	0.5975
28.	viii.	0.6949	0.4371	0.7400	0.5856	0.5157
29.	viii.	0.5967	0.4940	0.8420	0.7535	0.7031
30.	viii.	0.7659	0.4300	0.7455	0.6508	0.6000
31.	viii.	0.6687	0.3980	0.6625	0.5800	0.5380
1.	ix.	0.7138	0.4400	0.8610	0.6825	0.6445
2.	ix.	0.6278	0.3860	0.7545	0.5760	0.5465
3.	ix.	0.6680	0.4100	0.8700	0.5933	0.6953
4.	ix.	0.5880	0.3600	0.7500	0.5000	0.5978
5.	ix.	0.7555	0.4000	0.8668	0.5567	0.6996
6.	ix.	0.6395	0.3268	0.7470	0.4750	0.5978
7.	ix.	0.7000		0.8995	0.7400	0.6855
8.	ix.	0.6228		0.8000	0.6658	0.6065
9.	ix.	0.7140		0.8870	0.7261	0.6680
10.	ix.	0.6134		0.7818	0.6323	0.5700
11.	ix.	0.7060		0.8700	0.6958	0.6289
12.	ix.	0.5190		0.7623	0.6100	0.5500
13.	ix.	0.7187		0.8490	0.6564	0.6612
14.	ix.	0.6438		0.7534	0.5982	0.5850
15.	ix.	0.7313		0.8532	0.6278	0.6880
16.	ix.	0.6078		0.6830	0.5160	0.5700
17.	ix.	0.7540		0.7955	0.5500	0.7460
18.	ix.	0.6460		0.6644	0.4750	0.6365

Table 120. Growth in weight of *Phraortes kumamotoensis* in larval and adult stages.

Date	No. 49	No. 50	No. 51	No. 52	No. 53
11. vii.	0.4300	0.4100	0.4570	0.4338	0.4660
12. vii.	0.4743	0.4760	0.5268	0.4559	0.4920
13. vii.	0.5400	0.4850	0.5780	0.4860	0.5148
14. vii.	0.5700	0.5240	0.6139	0.5700	
15. vii.	0.5782	0.5065	0.6130	0.5565	0.4665
16. vii.	0.6200	0.4955	0.5900	0.5670	0.5000
17. vii.	0.6560	0.5058	0.5900	0.5500	0.5300
18. vii.	0.6430	0.5320	0.5750	0.5530	0.5100
19. vii.	0.6537	0.5420	0.5800	0.5587	0.4975
20. vii.	0.6665	0.5289	0.5950	0.5497	0.5080
21. vii.	0.6720	0.6070	0.5935	0.5668	0.4959
22. vii.	*0.7140	0.5885	*0.6234	0.6180	0.4400
23. vii.	0.6354	0.5668	0.5837	0.5850	0.4700
24. vii.	0.7200	0.6110	0.6250	0.6159	
25. vii.	0.7250	0.6095	0.7000	0.6200	0.4500
26. vii.	0.8050	0.6100	0.6700	0.6020	0.4400
27. vii.	0.7000	*0.6500	*0.6500	0.5960	0.4260
28. vii.	0.6800	0.6100	0.6490	0.5568	
29. vii.	0.7025	0.6210	0.6275	*0.5000	
30. vii.	0.7065	0.6140	0.6320	0.6020	
31. vii.	0.7400	0.6635	0.6500	0.5440	
1. viii.	0.7423	0.6580	0.6860		
2. viii.	0.7459	0.6295	0.6206	0.4786	
3. viii.	0.7578	0.6560	0.6850	0.5859	
4. viii.	0.7940	0.6431	0.7085	0.6020	
5. viii.	0.7762	0.6600	0.7055	0.5834	
6. viii.	0.7580	0.6748	0.6900		
7. viii.	0.7780	0.6352	0.7000	0.5700	
8. viii.	0.7895	0.6830	0.7000	0.6062	
9. viii.	0.7765	0.6722	0.7022	0.5788	
10. viii.	0.7947	0.6843	0.7542	0.6092	
11. viii.	0.7700	0.6828	0.7700	0.5975	

12.	viii.	0.7343	0.6587	0.7085	0.5725
13.	viii.	0.7630		0.7300	0.6134
14.	viii.	0.7421	0.6394	0.7290	0.5856
15.	viii.	0.7257	0.6492	0.6986	0.5700
16.	viii.	0.7220	0.6780	0.7415	0.6248
17.	viii.	0.7247	0.6760	0.7646	0.6480
18.	viii.	0.7369	0.6797	0.7592	0.7000
19.	viii.	0.7385	0.6547	0.7300	0.6500
20.	viii.	0.7486	0.6514	0.7278	0.6678
21.	viii.	0.7470	0.6200	0.7200	
22.	viii.	0.7550	0.6766	0.7200	0.6347
23.	viii.	0.7625	0.7093	0.7410	
24.	viii.	0.7400	0.7226	0.7332	0.5876
25.	viii.	0.7620	0.7000	0.7300	0.6600
26.	viii.	0.6912	0.6838	0.7577	0.6378
27.	viii.	0.6500	0.6600	0.7300	0.6468
28.	viii.	0.6240	0.7100	0.7200	0.6220
29.	viii.	0.5570	0.7400	0.6980	0.5700
30.	viii.	0.5300	0.6865	0.6710	0.5143
31.	viii.	0.4900	0.6835	0.6786	0.5531
1.	ix.			0.7787	0.6980
2.	ix.		0.6767	0.7500	0.5132
3.	ix.		0.6372	0.7735	
4.	ix.		0.6240	0.7525	
5.	ix.		0.5800	0.7300	
6.	ix.		0.5510	0.7070	
7.	ix.		0.6700	0.6980	
8.	ix.		0.6852	0.7049	
9.	ix.		0.6737	0.7010	
10.	ix.		0.6880	0.7350	
11.	ix.		0.6844	0.7315	
12.	ix.		0.7375		
13.	ix.		0.6654	0.8265	
14.	ix.			0.8300	
15.	ix.		0.7076	0.8790	
16.	ix.		0.6800	0.7500	
17.	ix.		0.6656	0.8067	
18.	ix.		0.6437	0.8137	

Table 121. Growth in weight of *Phraortes kumamotoensis* in larval and adult stages.

Date	No. 54	No. 55	No. 56	No. 57	No. 58
9. vii.	0.3820				
10. vii.	0.5160				
11. vii.	0.4460				
12. vii.	0.3960	0.3900			
13. vii.	0.4973	0.4890	0.3530	0.4273	
14. vii.	0.4300	0.4447	0.4150	0.4850	
15. vii.	0.5560	0.5755	0.3800	0.4510	
16. vii.	0.4800	0.5070	0.5000	0.5689	
17. vii.	0.6050	0.6115	0.4500	0.5200	0.3470
18. vii.	0.5598	0.5380	0.5290	0.7050	0.3338
19. vii.	0.6828	0.6953	0.4700	0.5940	0.4552
20. vii.	0.5800	0.5840	0.6335	0.7077	0.4138
21. vii.	0.6815	0.7200	0.5300	0.6150	0.5215
22. vii.	0.6053	*0.6050	0.6000	0.7640	0.4435
23. vii.	0.7370	0.7383	0.5290	*0.6625	0.4835
24. vii.	*0.6560	0.6570	0.6700	0.7880	0.4400
25. vii.	0.8000	0.7815	0.5700	0.6700	0.5090
26. vii.	0.6745	0.6500	*0.7200	0.8200	*0.4500
27. vii.	0.7630	0.8020	0.5980	0.7020	0.5100
28. vii.	0.6180	0.6300	0.6580	0.7600	0.4200
29. vii.	0.7200	0.6800	0.5495	0.6595	0.5300
30. vii.	0.6095	0.5950	0.6000	0.8280	0.4630
31. vii.	0.7384	0.7619	0.5400	0.6930	0.5500
1. viii.	0.6220	0.6300	0.5000	0.6298	0.4793
2. viii.	0.5174	0.5217	0.5793	0.7335	0.4036
3. viii.	0.6379	0.5784	0.5348	0.6587	0.5383
4. viii.	0.5399	0.4886	0.4890	0.6000	0.4700
5. viii.	0.4800	0.4349	0.5473	0.8064	0.4200
6. viii.	0.6400	0.4320	0.4565	0.6795	0.4420
7. viii.	0.5232		0.4328	0.6075	0.3875
8. viii.	0.4736		0.5062	0.7467	0.3630
9. viii.	0.6288		0.4615	0.6500	
10. viii.	0.5300		0.4238	0.5815	
11. viii.	0.4670		0.4048	0.5335	

12.	viii.	0.5700	0.6700
13.	viii.	0.5052	0.6036
14.	viii.	0.4427	0.5491
15.	viii.	0.5566	0.6678
16.	viii.	0.4816	0.5893
17.	viii.	0.4400	0.5478
18.	viii.	0.5800	0.6924
19.	viii.	0.4830	0.6078
20.	viii.	0.4234	0.5512
21.	viii.	0.5823	0.6666
22.	viii.	0.5047	0.4973
23.	viii.	0.4532	0.4600
24.	viii.	0.5175	0.5728
25.	viii.	0.4510	0.5048
26.	viii.	0.4145	0.4624
27.	viii.	0.5180	0.5670
28.	viii.	0.4450	0.5078
29.	viii.	0.4115	0.4802
30.	viii.	0.5179	0.6272
31.	ix.	0.4462	0.5578
1.	ix.	0.4015	0.5185
2.	ix.	0.4328	0.5708
3.	ix.		0.5135
4.	ix.		0.4745
5.	ix.		0.5750
6.	ix.		0.5078
7.	ix.		0.4828
8.	ix.		0.5818
9.	ix.		0.5328
10.	ix.		0.5026
11.	ix.		0.5560
12.	ix.		0.5048
13.	ix.		0.4930
14.	ix.		0.5508
15.	ix.		0.5213
16.	ix.		0.4706
17.	ix.		0.5310
18.	ix.		0.4838

Table 122. Amount of leaves eaten by *Phraortes kumamotoensis* No. 44 in larval and adult stages.

Date	V (average of three days)	V	O	W
7. vii.	449.0	396.0	2732	3643
8. vii.		246.0	1697	2263
9. vii.	739.0	528.7	3648	4864
10. vii.		246.0	1697	2263
11. vii.	739.0	428.7	2706	3944
12. vii.		182.3	1258	1677
13. vii.	547.0	381.0	2629	3505
14. vii.		198.7	1371	1828
15. vii.	596.0	349.0	2408	3211
16. vii.		147.0	1026	1352
17. vii.	441.0	397.0	2760	3652
18. vii.		250.0	1725	2300
19. vii.	750.0	453.0	3206	4168
20. vii.		203.0	1401	1868
21. vii.	609.0	490.7	3386	4514
22. vii.		287.7	1985	2647
23. vii.	863.0	496.0	3422	4563
24. vii.		208.3	3437	1916
25. vii.	625.0	468.7	3234	4312
26. vii.		260.3	1796	2395
27. vii.	781.0	505.0	3485	4646
28. vii.		244.7	1688	2251
29. vii.	734.0	462.0	3188	4250
30. vii.		217.3	1499	1999
31. vii.	652.0	455.3	3146	4189
1. viii.		238.0	1642	2190
2. viii.	714.0	451.7	3118	4156
3. viii.		213.7	1474	1956
4. viii.	641.0	563.0	3885	5180
5. viii.		349.3	2410	3214
6. viii.	1048.0	615.3	4246	5661
7. viii.		266.0	1835	2447
8. viii.	798.0	437.7	3029	4027
9. viii.		171.7	1185	1580
10. viii.	515.0	431.0	2974	3965

11.	viii.		259.3	1789	2386
12.	viii.	778.9	451.7	3117	4156
13.	viii.		192.3	1327	1769
14.	viii.	577.0	442.0	3050	4066
15.	viii.		249.7	1724	2297
16.	viii.	749.0	503.3	3473	4630
17.	viii.		253.7	1751	2334
18.	viii.	761.0	457.3	3155	4197
19.	viii.		203.7	1406	1874
20.	viii.	611.0	327.7	2261	3015
21.	viii.		124.0	856	1141
22.	viii.	372.0	321.3	2217	2956
23.	viii.		197.3	1361	1815
24.	viii.	592.0	410.7	2834	3778
25.	viii.		213.3	1472	1963
26.	viii.	640.0	394.7	2725	3631
27.	viii.		181.3	1251	1668
28.	viii.	544.0	470.3	3245	4327
29.	viii.		289.0	1994	2659
30.	viii.	867.0	401.0	2767	3689
31.	viii.		112.0	773	1030
1.	ix.	336.0	271.3	1872	2496
2.	ix.		159.3	1099	1466
3.	ix.	478.0	406.3	2803	3738
4.	ix.		247.0	1704	2272
5.	ix.	741.0	415.7	2868	3824
6.	ix.		168.7	1164	1552
7.	ix.	506.0	435.7	3007	4008
8.	ix.		267.0	1842	2456
9.	ix.	801.0	431.7	3324	4435
10.	ix.		214.7	1481	1975
11.	ix.	644.0	389.0	2684	3579
12.	ix.		174.3	1203	1604
13.	ix.	523.0	345.0	2381	3174
14.	ix.		170.7	1178	1570
15.	ix.	512.0	373.7	2580	3438
16.	ix.				
17.	ix.	609.0			

Table 1 3. Amount of leaves eaten by *Phraortes kumamotoensis*
No. 49 in larval and adult stages.

Date	V (average of three days)	V	O	W
11. vii.	36.5	115.2	795	1060
12. vii.	144.0	168.7	1164	1552
13. vii.	165.0	188.0	1297	1730
14. vii.	197.0	208.0	1435	1914
15. vii.	202.0	226.5	1569	2083
16. vii.	225.0	231.5	1597	2130
17. vii.	252.5	221.2	1526	2034
18. vii.	217.0	211.7	1461	1948
19. vii.	194.0	242.0	1670	2226
20. vii.	224.0	255.3	1764	2349
21. vii.	308.0	248.3	1713	2284
22. vii.	234.0	231.3	1596	2128
23. vii.	203.0	241.0	1663	2217
24. vii.	257.0	289.3	2056	2662
25. vii.	263.0	286.7	1979	2638
26. vii.	348.0	291.3	2010	2680
27. vii.	249.0	249.7	1723	2297
28. vii.	277.0	233.3	1610	2146
29. vii.	223.0	236.7	1633	2178
30. vii.	200.0	254.7	1755	2343
31. vii.	287.0	292.3	2017	2689
1. viii.	277.0	278.3	1920	2560
2. viii.	313.0	282.8	1951	2602
3. viii.	245.0	254.8	1758	2344
4. viii.	290.5	266.5	1839	2452
5. viii.	229.0	264.2	1823	2431
6. viii.	280.0	264.3	1824	2432
7. viii.	283.0	249.7	1723	2297
8. viii.	230.0	236.7	1633	2178
9. viii.	236.0	329.0	2270	3027
10. viii.	244.0	343.0	2367	3156
11. viii.	507.0	362.3	2500	3333
12. viii.	278.0	294.0	2029	2705
13. viii.	302.0	295.7	2040	2720

14.	viii.	302.0	297.3	2051	2735
15.	viii.	283.0	301.3	2079	2772
16.	viii.	307.0	308.0	2125	2834
17.	viii.	314.0	280.3	1934	2579
18.	viii.	303.0	242.7	1795	2233
19.	viii.	224.0	276.0	1904	2539
20.	viii.	201.0	277.3	1913	2551
21.	viii.	403.0	293.3	2024	2698
22.	viii.	228.0	242.0	1670	2226
23.	viii.	249.0	221.7	1530	2040
24.	viii.	249.0	198.7	1371	1828
25.	viii.	167.0	187.3	1292	1723
26.	viii.	180.0	172.7	1192	1589
27.	viii.	215.0	196.7	1357	1810
28.	viii.	123.0	156.7	1081	1432
29.	viii.	262.0	122.7	847	1120
30.	viii.	85.0			
31.	viii.	21.0			

Table 124. Amount of leaves eaten by *Phraortes kumamotoensis* No. 54 in larval and adult stages.

Date	V (average of three days)	V	O	W
10. vii.	342.0	114.0	787	1049
11. vii.		143.0	987	1316
12. vii.		143.0	987	1316
13. vii.	429.0	320.0	2208	2944
14. vii.		177.0	1221	1628
15. vii.	531.0	391.3	2700	3600
16. vii.		214.3	1479	1972
17. vii.	643.0	552.7	3814	5085
18. vii.		338.3	2334	3112
19. vii.		706.3	4873	6498
20. vii.		368.0	2539	3386
21. vii.	1104.0	753.7	5201	6934
22. vii.		385.7	2661	3548
23. vii.	1157.0	602.0	4154	5538
24. vii.		216.3	1392	1990

25.	vii	649.0	439.7	3034	4045
26.	vii.		223.3	1541	2054
27.	vii.	670.0	551.0	3802'	5069
28.	vii.		327.7	2261	3015
29.	vii.	983.0	561.0	3871	5161
30.	vii.		233.3	1610	2146
31.	vii.	700.0	233.3	1610	2146
1.	viii.		234.3	1617	2156
2.	viii.		234.3	1617	2156
3.	viii.	703.0	234.3	1617	2156
4.	viii.		336.0	2318	3091
5.	viii.		336.0	2318	3091
6.	viii.	1008.0	336.0	2318	3091
7.	viii.		248.3	1713	2284
8.	viii.		248.3	1713	2284
9.	viii.	745.0	248.3	1713	2284
10.	viii.		274.3	1893	2524
11.	viii.		274.3	1893	2524
12.	viii.	823.0	274.3	1893	2524
13.	viii.		243.3	1679	2238
14.	viii.		243.3	1679	2238
15.	viii.	730.0	243.3	1679	2238
16.	viii.		168.0	1159	1546
17.	viii.		168.0	1159	1546
18.	viii.	504.0	168.0	1159	1546
19.	viii.		207.3	1430	1907
20.	viii.		207.3	1430	1907
21.	viii.	622.0	207.3	1430	1907
22.	viii.		161.3	1113	1484
23.	viii.		161.3	1113	1484
24.	viii.	484.0	161.3	1113	1484
25.	viii.		162.0	1118	1490
26.	viii.		162.0	1118	1490
27.	viii.	486.0	162.0	1118	1490
28.	viii.		155.0	1070	1426
29.	viii.		155.0	1070	1426
30.	viii.	465.0	155.0	1070	1426
31.	viii.		91.7	633	844
1.	ix.				
2.	ix.	275.0			

Table 125. Variation in size of eggs dropped by *Phraortes kumamotoensis* No. 44 during her life.

Date	Number	Shape	a	b	c	d	e	f	g	h	i
18. vii.	1	△	2.500	1.500	1.200	1.000	0.750	1.500	0.500	0.250	0.250
20. vii.	1	△	2.450	1.600	1.200	1.000	0.800	1.650	0.550	0.350	0.250
21. vii.	1	△	2.500	1.600	1.250	1.100	0.800	1.600	0.550	0.350	0.250
22. vii.	5	△	2.550	1.600	1.250	1.100	0.750	1.650	0.550	0.250	0.250
"		△	2.500	1.500	1.300	1.050	0.900	1.550	0.550	0.250	0.300
"		△	2.550	1.650	1.250	1.050	0.800	1.550	0.550	0.250	0.250
"		△	2.500	1.500	1.200	1.000	0.750	1.700	0.550	0.300	0.300
"		△	2.500	1.550	1.850	1.100	0.800	1.750	0.600	0.300	0.300
24. vii.	2	○	2.600	1.500	1.250	1.050	0.800	1.500	0.550	0.450	0.300
"		△	2.750	1.700	1.400	1.100	0.850	1.700	0.600	0.350	0.250
25. vii.	1	△	2.500	1.500	1.300	1.050	0.750	1.600	0.600	0.250	0.250
26. vii.	2	△	2.750	1.900	1.500	1.100	0.900	1.750	0.550	0.250	0.250
"		×	2.250	1.250	1.050	0.900	0.600	1.400	0.500		
28. vii.	4	△	2.750	1.750	1.500	1.100	0.950	1.750	0.550	0.250	0.200
"		△	2.750	1.800	1.500	1.150	0.900	1.700	0.550	0.250	0.150
"		△	2.750	1.800	1.500	1.250	0.950	1.650	0.550	0.200	0.150
"		△	2.750	1.750	1.400	1.100	0.900	1.600	0.550	0.300	0.250
29. vii.	2	○	2.750	1.750	1.500	1.100	0.800	1.750	0.550	0.350	0.250
"		△	2.600	1.750	1.500	1.200	0.900	1.750	0.550	0.250	0.250
30. vii.	3	△	2.600	1.750	1.500	1.200	1.000	1.600	0.500	0.250	0.300
"		△	2.500	1.800	1.500	1.250	1.000	1.600	0.600	0.300	0.250
"		△	2.750	1.750	1.500	1.200	0.900	1.750	0.600	0.250	0.300
1. viii.	6	△	2.650	1.750	1.500	1.250	0.900	1.600	0.550	0.350	0.200
"		△	2.500	1.700	1.500	1.150	0.900	1.600	0.550	0.200	0.200
"		△	2.650	1.700	1.400	1.150	0.850	1.600	0.550	0.300	0.200
"		△	2.600	1.700	1.500	1.150	0.850	1.600	0.550	0.300	0.200
"		△	2.500	1.700	1.500	1.200	0.850	1.600	0.550	0.200	0.200
"		△	2.550	1.800	1.400	1.100	0.900	1.600	0.550	0.200	0.200
2. viii.	2	△	2.500	1.700	1.400	1.100	0.900	1.500	0.500	0.150	0.150
"		△	2.500	1.650	1.500	1.100	0.850	1.600	0.550	0.250	0.200
3. viii.	2	△	2.500	1.700	1.250	1.100	0.850	1.500	0.550	0.550	0.250
"		△	2.550	1.650	1.400	1.100	0.900	1.600	0.550	0.250	0.200
4. viii.	1	△	2.650	1.700	1.400	1.150	0.950	1.700	0.550	0.200	0.250
5. viii.	1	○	2.250	1.400	1.200	1.000	0.600	1.250	0.500	0.300	0.250
6. viii.	1	×	2.600	1.750	1.400	1.100	0.900	1.700	0.500		

7.	viii.	5	×	2.650	1.700	1.500	1.100	0.900	1.750	0.550		
"			△	2.750	1.750	1.500	1.150	0.950	1.700	0.550	0.300	0.200
"			△	2.750	1.750	1.500	1.150	0.950	1.800	0.550	0.200	0.200
"			△	2.650	1.700	1.450	1.100	0.850	1.600	0.550	0.200	0.150
7.	viii.		△	2.700	1.750	1.350	1.150	0.900	1.650	0.550	0.250	0.150
8.	viii.	1	△	2.750	1.750	1.400	1.100	0.800	1.650	0.550	0.200	0.100
9.	viii.	2	△	2.750	1.750	1.500	1.100	0.900	1.750	0.550	0.300	0.200
"			△	2.650	1.750	1.400	1.150	0.900	1.600	0.550	0.300	0.200
11.	viii.	4	△	2.650	1.750	1.400	1.100	0.850	1.600	0.550	0.350	0.200
"			△	2.600	1.650	1.400	1.100	0.850	1.750	0.550	0.250	0.200
"			△	2.500	1.650	1.500	1.050	0.900	1.500	0.600	0.300	0.200
"			△	2.550	1.650	1.350	1.100	0.800	1.600	0.550	0.200	0.200
12.	viii.	1										
14.	viii.	1	△	2.400	1.500	1.250	1.000	0.750	1.500	0.550	0.200	0.200
15.	viii.	1	△	2.500	1.600	1.250	1.100	0.900	1.750	0.600	0.250	0.300
16.	viii.	1	△	2.550	1.650	1.250	1.050	0.850	1.700	0.600	0.200	0.150
17.	viii.	1	△	2.250	1.500	1.200	1.050	0.750	1.400	0.550	0.350	0.200
18.	viii.	1	△	2.400	1.500	1.200	1.000	0.700	1.250	0.550	0.250	0.200
19.	viii.	1	○	2.750	1.700	1.200	1.050	0.850	1.700	0.550	0.350	0.200
21.	viii.	3		2.600	1.750	1.300	1.200	0.850	1.700	0.550		
"				2.750	1.750	1.400	1.150	0.750	1.600	0.550		
"				2.750	1.750	1.400	1.200	0.800	1.750	0.550		
22.	viii.	1		2.500	1.800	1.300	1.200	0.900	1.500	0.550		
24.	viii.	2	△	2.500	1.600	1.300	1.100	0.850	1.600	0.600	0.300	0.200
"				2.500	1.650	1.250	1.150	0.900	1.500	0.550		
25.	viii.	5	△	2.300	1.450	1.100	1.050	0.750	1.400		0.250	0.150
"			△	2.500	1.500	1.200	1.000	0.800	1.250	0.550	0.300	0.100
"			△	2.450	1.600	1.250	1.100	0.800	1.650	0.600	0.300	0.200
"			△	2.400	1.500	1.300	1.000	0.800	1.500	0.550	0.300	0.250
"			△	2.300	1.500	1.250	1.000	0.800	1.600	0.500	0.300	0.200
26.	viii.	1	△	2.400	1.500	1.200	1.000	0.750	1.750	0.550	0.200	0.200
29.	viii.		△	2.800	1.900	1.400	1.250	0.900	1.600	0.550	0.300	0.100
31.	viii.	2		2.100	1.500	1.100	0.900	0.650	1.250			
"				2.500	1.750	1.400	1.150	0.900	1.600	0.550		
1.	ix.	2		2.300	1.300	1.000	0.900	0.500	1.000			
"				2.750	1.750	1.500	1.200	0.900	1.600	0.600		
2.	ix.	1		2.650	1.750	1.400	1.200	0.950	1.600	0.550		
4.	ix.	2		2.600	1.650	1.300	1.100	0.700	1.600	0.550		

"				2.500	1.750	1.400	1.100	0.900	1.700	0.550		
5.	ix.	2		2.500	1.750	1.300	1.100	0.900	1.750	0.600		
"				2.700	1.750	1.450	1.100	0.850	1.900	0.550		
6.	ix.	1		2.550	1.650	1.250	1.100	0.750	1.600	0.550		
8.	ix.	2		2.300	1.600	1.250	1.000	0.750	1.650	0.550		
"				2.500	1.700	1.300	1.100	0.800	1.150	0.550		
9.	ix.	1	△	2.500	1.650	1.250	1.050	0.750	1.900	0.550	0.300	0.200
10.	ix.	2		2.550	1.700	1.400	1.100	0.750	1.750	0.600		
"				2.600	1.800	1.500	1.050	0.800	1.650	0.550		
17.	ix.	2		2.800	1.900	1.500	1.250	0.900	1.800	0.550		
"				2.750	1.750	1.500	1.100	0.800	1.600	0.550		
18.	ix.	1		2.700	1.750	1.300	1.150	0.750	1.750	0.600		
19.	ix.	3		2.400	1.500	1.000	1.050	0.750	1.250	0.500		
"				2.750	1.900	1.300	1.200	0.750	1.600	0.600		
"				2.750	1.800	1.500	1.100	0.850	1.600	0.600		
Maximum				2.800	1.900	1.850	1.250	1.000	1.900	0.600	0.450	0.300
Minimum				2.100	1.250	1.000	0.900	0.500	1.000	0.500	0.150	0.100
Average				2.556	1.668	1.354	1.102	0.832	1.609	0.554	0.275	0.214

Table 126. Variation in size of eggs dropped by *Phraortes kumamotoensis* No 45. during her life.

Date	Number	Shape	a	b	c	d	e	f	g	h	i
21. vii.	1	△	2.350	1.200	1.000	0.750	0.750	1.500	0.550	0.300	0.400
22. vii.	1	○	2.400	1.450	1.050	0.750	0.750	1.750	0.550	0.450	0.250
23. vii.	2	○	2.500	1.500	1.200	0.800	0.800	1.800	0.550	0.500	0.350
"		○	2.500	1.450	1.100	0.900	0.750	1.900	0.500	0.500	0.500
25. vii.	1	○	2.750	1.500	1.150	0.900	0.700	2.000	0.450	0.450	0.450
27. vii.	2	○	2.500	1.500	1.150	0.900	0.750	1.900	0.550	0.500	0.500
"		△	2.600	1.400	1.100	1.000	0.800	1.800	0.500	0.300	0.300
28. vii.	1	△	2.500	1.400	1.150	1.000	0.850	1.700	0.550	0.500	0.300
29. vii.	1	○	2.500	1.250	1.000	0.900	0.750	1.700	0.500	0.500	0.400
1. viii.	2	△	2.900	1.700	1.200	1.000	0.850	1.800	0.550	0.400	0.450
"		△	2.800	1.650	1.250	1.000	0.900	1.700	0.600	0.350	0.400
3. viii.	1	○	2.750	1.700	1.200	1.000	0.750	2.000	0.550	0.500	0.500
4. viii.	1										
5. viii.	1	△	2.600	1.500	1.200	0.900	0.750	1.700	0.600	0.500	0.200
7. viii.	2	△	2.500	1.700	1.200	1.050	0.800	1.600	0.550	0.500	0.400

"		△	2.500	1.700	1.150	0.750	0.650	1.750	0.550	0.500	0.200
9. viii.	1	△	2.500	1.700	1.250	1.000	0.800	1.800	0.550	0.400	0.450
10. viii.	1	·	2.700	1.650	1.400	1.000	0.800	2.000	0.600		
11. viii.	1	×	2.750	1.650	1.300	0.950	0.850	1.700	0.550		
12. viii.	1	○	2.750	1.750	1.250	1.000	0.850	2.000	0.550	0.500	0.250
14. viii.	3	△	2.750	1.600	1.250	0.900	0.800	1.750	0.500	0.450	0.250
"		△	2.700	1.650	1.000	0.900	0.700	1.900	0.500	0.450	0.450
"		△	2.600	1.650	1.250	1.000	0.850	2.000	0.500	0.350	0.300
16. viii.	1	△	2.750	1.700	1.250	1.000	0.800	1.750	0.550	0.350	0.450
17. viii.	1	△	2.650	1.500	1.250	0.750	0.750	1.750	0.550	0.450	0.150
18. viii.	2	△	2.500	1.500	1.150	0.950	0.750	0.800	0.550	0.350	0.250
"		△	2.600	1.600	1.250	0.950	0.800	1.700	0.550	0.550	0.400
22. viii.	1	△	2.900	1.750	1.500	1.050	1.000	2.150	0.550	0.300	0.200
27. viii.		△	2.750	1.700	1.250	1.000	0.850	1.900	0.550	0.400	0.300
29. viii.	1	△	2.900	1.800	1.300	1.050	0.800	1.850	0.550	0.250	0.150
1. xi.	1	△	2.700	1.750	1.250	1.000	0.800	1.900	0.600	0.350	0.250
2. xi.	2	△	2.500	1.500	1.200	1.000	0.700	1.650	0.450	0.300	0.450
"		△	2.600	1.750	1.250	0.800	0.750	1.500	0.550	0.350	0.350
4. xi.	1										
Maximum			2.900	1.800	1.500	1.050	1.000	2.150	0.600	0.550	0.500
Minimum			2.350	1.200	1.000	0.750	0.650	1.500	0.450	0.250	0.150
Average			2.620	1.587	1.201	0.934	0.789	1.790	0.540	0.418	0.341

Table 127. Variation in size of eggs dropped by *Phraortes kumamotoensis* No. 46 during her life.

Date	Number	Shape	a	b	c	d	e	f	g	h	i
17. vii.	4		2.700	1.500	1.250	1.050	0.750	1.750	0.500		
"		○	2.750	1.600	1.150	1.000	0.750	1.600	0.500	0.450	0.350
"		○	2.750	1.500	1.100	1.000	0.750	1.900	0.500	0.500	0.450
"		△	2.750	1.700	1.250	1.050	0.900	1.800	0.550	0.300	0.350
19. vii.	2	△	2.600	1.600	1.250	1.000	0.900	1.750	0.500	0.200	0.300
"		△	2.700	1.600	1.200	1.000	0.750	1.750	0.550	0.450	0.450
20. vii.	1	△	2.650	1.650	1.300	1.100	0.900	1.800	0.550	0.350	0.350
21. vii.	2	△	2.650	1.600	1.250	1.100	0.900	1.900	0.550	0.250	0.450
"		△	2.700	1.700	1.400	1.100	0.950	1.800	0.550	0.200	0.350
22. vii.	1	△	2.600	1.500	1.250	1.050	0.900	1.750	0.550	0.300	0.350
23. vii.	4	△	2.650	1.600	1.250	1.100	0.900	1.750	0.600	0.350	0.350

			△	2.600	1.600	1.300	1.050	0.900	1.750	0.600	0.250	0.350
			○	2.700	1.800	1.500	1.050	0.900	1.900	0.550	0.500	0.450
			○	2.700	1.650	1.400	1.050	0.900	1.750	0.550	0.500	0.500
24.	vii.	2	△	2.750	1.750	1.250	1.200	0.900	1.800	0.550	0.450	0.250
			△	2.750	1.700	1.350	1.050	0.800	1.750	0.550	0.500	0.450
25.	vii.	2	△	2.700	1.700	1.300	1.100	0.900	1.800	0.550	0.350	0.350
			△	2.700	1.750	1.500	1.100	0.850	1.750	0.550	0.300	0.300
26.	vii.	1	△	2.750	1.700	1.300	1.100	0.900	1.700	0.550	0.300	0.350
27.	vii.	3	△	2.750	1.750	1.500	1.050	0.900	1.700	0.550	0.450	0.400
			△	2.600	1.650	1.300	1.100	0.950	1.600	0.550	0.300	0.400
			○	2.700	1.700	1.350	1.100	0.900	1.900	0.550	0.500	0.350
28.	vii.	3	△	2.600	1.700	1.500	1.100	0.950	1.700	0.500	0.350	0.400
			△	2.700	1.700	1.400	1.100	0.950	1.750	0.550	0.250	0.350
			△	2.700	1.750	1.500	1.100	0.900	1.800	0.550	0.350	0.350
29.	vii.	4	△	2.600	1.650	1.250	1.150	0.900	1.700	0.550	0.350	0.350
			△	2.600	1.650	1.300	1.050	0.850	1.750	0.550	0.300	0.350
			△	2.650	1.700	1.400	1.100	0.900	1.800	0.550	0.350	0.350
			○	2.700	1.650	1.500	1.100	0.900	1.750	0.600	0.500	0.400
30.	vii.	2	△	2.500	1.600	1.300	1.050	0.900	1.700	0.550	0.500	0.500
			△	2.550	1.500	1.300	1.100	0.900	1.600	0.550	0.400	0.400
31.	vii.	3	○	2.500	1.700	1.450	1.100	0.850	1.800	0.550	0.500	0.400
			○	2.700	1.750	1.500	1.100	0.800	1.800	0.550	0.500	0.450
			○	2.500	1.750	1.300	1.100	0.750	1.600	0.550	0.500	0.500
2.	viii.	5	△	2.600	1.750	1.300	1.100	0.800	1.700	0.550	0.350	0.350
			△	2.650	1.700	1.300	1.100	0.900	1.600	0.550	0.300	0.350
			△	2.800	1.750	1.550	1.100	0.950	1.750	0.550	0.200	0.350
			○	2.550	1.700	1.500	1.100	0.900	1.750	0.550	0.450	0.450
			△	2.600	1.650	1.250	1.100	0.900	1.800	0.500	0.300	0.350
3.	viii.	2	△	2.600	1.700	1.750	1.100	0.800	1.600	0.500	0.300	0.350
			△	2.600	1.700	1.300	1.100	0.950	1.650	0.550	0.350	0.350
4.	viii.	1	○	2.600	1.600	1.300	1.100	0.900	1.750	0.550	0.500	0.450
5.	viii.	1	△	2.650	1.600	1.250	1.150	0.800	1.750	0.550	0.300	0.350
6.	viii.	3	△	2.600	1.600	1.250	1.100	0.900	1.650	0.600	0.300	0.350
			△	2.650	1.650	1.250	1.100	0.900	1.750	0.500	0.250	0.350
			△	2.650	1.600	1.150	1.100	0.950	1.750	0.550	0.350	0.350
7.	viii.	2	△	2.500	1.500	1.250	1.100	0.900	1.700	0.600	0.500	0.450
			△	2.500	1.650	1.350	1.100	0.900	1.800	0.600	0.500	0.500
9.	viii.	1	○	2.600	1.600	1.300	1.000	0.850	1.850	0.600	0.500	0.500

10.	viii.	3	△	2.550	1.500	1.250	1.100	0.800	1.750	0.550	0.450	0.350
	"		△	2.500	1.550	1.300	1.000	0.800	1.700	0.600	0.500	0.250
	"		△	2.550	1.550	1.350	1.100	0.800	1.700	0.600	0.300	0.200
11.	viii.	1	△	2.600	1.600	1.250	1.100	0.850	1.750	0.600	0.500	0.400
12.	viii.	1										
13.	viii.	1	△	2.300	1.500	1.200	1.050	0.900	1.400	0.550	0.500	0.300
14.	viii.	6	○	2.250	1.500	1.050	0.950	0.750	1.600	0.550	0.500	0.350
	"		△	2.500	1.500	1.100	0.950	0.800	1.650	0.550	0.200	0.250
	"		△	2.300	1.500	1.150	1.050	0.900	1.500	0.550	0.350	0.300
	"		△	2.300	1.500	1.150	1.000	0.750	1.700	0.550	0.300	0.300
	"		△	2.250	1.600	1.100	1.000	0.750	1.600	0.550	0.300	0.250
	"		○	2.400	1.500	1.100	1.000	0.800	1.650	0.550	0.450	0.300
16.	viii.	1	△	2.550	1.700	1.300	1.100	0.900	1.750	0.550	0.300	0.250
17.	viii.	2	△	2.500	1.700	1.250	1.050	0.800	1.700	0.550	0.450	0.300
	"		△	2.500	1.650	1.300	1.100	0.800	1.600	0.550	0.350	0.300
18.	viii.	2	△	2.600	1.750	1.300	1.100	0.900	1.900	0.550	0.250	0.250
	"		△	2.700	1.500	1.300	1.100	0.950	1.750	0.550	0.500	0.250
19.	viii.	2	○	2.500	1.600	1.300	1.100	0.900	1.750	0.600	0.500	0.350
	"		△	2.550	1.600	1.400	1.100	0.900	1.700	0.600	0.250	0.200
20.	viii.	3	△	2.600	1.550	1.350	1.100	0.950	1.650	0.550	0.300	0.250
	"		△	2.350	1.550	1.250	1.100	0.800	1.600	0.550	0.350	0.350
	"		△	2.500	1.650	1.200	1.100	0.750	1.750	0.550	0.350	0.300
21.	viii.	2	△	2.650	1.650	1.250	1.100	0.900	1.800	0.550	0.350	0.350
	"		△	2.500	1.500	1.250	1.050	0.950	1.650	0.550	0.350	0.300
22.	viii.	3	△	2.500	1.600	1.250	1.100	0.800	1.750	0.600	0.400	0.300
	"		△	2.500	1.500	1.200	1.550	0.850	1.800	0.550	0.250	0.200
	"		△	2.450	1.600	1.250	1.000	0.800	1.750	0.550	0.300	0.300
23.	viii.	1	△	2.200	1.500	1.100	1.050	0.800	1.650	0.550	0.300	0.300
24.	viii.	2	△	2.300	1.500	1.200	1.050	0.900	1.800	0.550	0.350	0.350
	"		△	2.450	1.500	1.250	1.050	0.850	1.800	0.550	0.300	0.250
26.	viii.	5	△	2.350	1.500	1.150	1.000	0.900	1.900	0.550	0.350	0.300
	"		△	2.500	1.700	1.300	1.150	0.900	1.950	0.600	0.450	0.400
	"		△	2.300	1.500	1.250	1.100	0.900	1.750	0.600	0.350	0.350
	"		△	2.500	1.600	1.250	1.100	0.900	1.950	0.600	0.350	0.300
	"		○	2.500	1.650	1.250	1.200	0.900	1.900	0.550	0.500	0.300
Maximum				2.800	1.800	1.500	1.200	0.950	1.950	0.600	0.500	0.500
Minimum				2.200	1.500	1.050	0.950	0.750	1.400	0.500	0.200	0.200
Average				2.568	1.615	1.288	1.077	0.866	1.737	0.554	0.373	0.348

Table 128. Variation in size of eggs dropped by *Phraortes kumamotoensis* No. 47 during her life.

Date	Number	Shape	a	b	c	d	e	f	g	h	i
19. vii.	1	○	2.500	1.500	1.150	1.000	0.850	1.750	0.550	0.500	0.500
21. vii.	2	△	2.600	1.650	1.300	1.050	0.950	1.900	0.600	0.250	0.500
"		○	2.750	1.650	1.200	1.000	0.900	1.900	0.600	0.500	0.500
22. vii.	1	○	2.750	1.500	1.250	1.000	0.900	2.000	0.550	0.500	0.500
23. vii.	1	○	2.750	1.700	1.300	1.000	0.850	2.000	0.600	0.500	0.500
24. vii.	1	○	2.600	1.600	1.250	1.100	0.900	1.900	0.550	0.500	0.500
25. vii.	3	○	2.650	1.700	1.400	1.100	0.850	1.700	0.550	0.500	0.500
"		○	2.700	1.700	1.400	1.150	1.000	1.750	0.550	0.500	0.450
"		△	2.700	1.750	1.500	1.150	0.950	1.900	0.600	0.500	0.500
27. vii.	3	○	2.700	1.750	1.400	1.100	0.900	1.750	0.600	0.500	0.450
"		○	2.600	1.800	1.400	1.100	0.900	1.700	0.550	0.500	0.500
"		○	2.700	1.650	1.400	1.050	0.900	1.900	0.550	0.500	0.400
29. vii.	1	△	2.750	1.700	1.300	1.100	0.800	1.750	0.550	0.500	0.500
30. vii.	3	○	2.500	1.700	1.400	1.100	0.900	1.900	0.600	0.500	0.500
"		○	2.650	1.650	1.300	1.100	0.900	1.900	0.600	0.500	0.500
"		△	2.500	1.700	1.350	1.050	1.000	1.900	0.600	0.500	0.500
31. vii.	2	△	2.750	1.750	1.400	1.100	1.000	1.950	0.550	0.400	0.450
"		○	2.650	1.700	1.300	1.100	0.950	1.800	0.600	0.500	0.500
1. viii.	1	○	2.650	1.700	1.400	1.050	0.950	1.700	0.600	0.500	0.500
2. viii.	1	△	2.800	1.850	1.500	1.100	0.900	2.000	0.600	0.500	0.400
3. viii.	1		2.500	1.700	1.400	1.100	0.900	1.600	0.550		
4. viii.	3	△	2.750	1.750	1.300	1.100	0.900	1.900	0.550	0.500	0.400
"		○	2.650	1.750	1.500	1.100	0.950	1.800	0.550	0.500	0.500
"		○	2.650	1.900	1.400	1.150	0.950	2.000	0.550	0.500	0.500
6. viii.	2	○	2.500	1.650	1.400	1.100	0.900	1.500	0.500	0.500	0.500
"		△	2.500	1.650	1.250	1.100	0.950	1.600	0.500	0.500	0.500
7. viii.	4	△	2.600	1.650	1.300	1.100	1.000	1.700	0.550	0.550	0.350
"		△	2.500	1.650	1.250	1.050	0.850	1.700	0.550	0.550	0.450
"		○	2.400	1.500	1.250	1.000	1.000	1.600	0.550	0.550	0.500
"		○	2.550	1.600	1.400	1.100	0.900	1.750	0.500	0.550	0.500
8. viii.	2	△	2.600	1.650	1.300	1.050	0.900	1.750	0.550	0.400	0.450
"		○	2.500	1.500	1.300	1.000	0.900	1.650	0.550	0.500	0.500
10. viii.	2	○	2.700	1.700	1.500	1.200	0.800	1.900	0.600	0.500	0.500
"		△	2.750	1.800	1.500	1.100	0.850	1.900	0.600	0.500	0.200

11.	viii.	1	△	2.750	1.750	1.500	1.100	0.950	1.800	0.550	0.500	0.400
13.	viii.	2	△	2.500	1.700	1.850	1.100	0.900	1.900	0.550	0.500	0.500
	"		△	2.600	1.700	1.400	1.100	0.900	1.650	0.550	0.500	0.400
14.	viii.	1	○	2.500	1.800	1.900	1.000	0.950	1.750	0.600	0.500	0.500
16.	viii.	1	△	2.160	1.200	1.000	0.800	0.750	1.100	0.250	0.300	0.350
18.	viii.	3	○	2.700	1.900	1.400	1.150	0.950	2.000	0.550	0.500	0.500
	"		△	2.750	1.700	1.500	1.100	0.900	1.900	0.600	0.500	0.500
	"		△	2.750	1.850	1.500	1.150	0.900	2.000	0.600	0.450	0.350
20.	viii.	2	○	2.700	1.750	1.500	1.100	0.850	2.000	0.600	0.350	0.350
	"		△	2.650	1.700	1.250	0.600	0.900	1.900	0.550	0.500	0.500
23.	viii.	1	△	2.800	1.900	1.350	1.150	0.900	2.000	0.600	0.450	0.350
26.	viii.	3	○	2.850	1.900	1.450	1.150	1.000	2.100	0.600	0.550	0.500
	"		△	2.700	1.800	1.300	1.100	0.900	1.800	0.550	0.550	0.500
	"		△	2.850	1.750	1.350	1.200	0.850	1.900	0.550	0.250	0.350
28.	viii.	2	△	2.800	1.750	1.500	1.200	0.950	2.100	0.650	0.250	0.450
	"		△	2.700	1.750	1.500	1.200	0.900	2.000	0.600	0.300	0.400
2.	ix.	1	△	2.700	1.700	1.250	1.100	0.950	1.750	0.550	0.200	0.250
4.	ix.	2		2.500	1.500	1.250	0.900	0.900	1.000	0.500		
	"			2.700	1.650	1.250	1.050	0.850	1.750	0.500		
8.	ix.	2		2.500	1.750	1.400	1.050	0.950	1.750	0.550		
	"			2.650	1.700	1.350	1.100	1.000	1.800	0.550		
9.	ix.	1		2.600	1.700	1.250	1.000	0.750	1.600	0.500		
10.	ix.	2		2.500	1.700	1.250	1.050	1.000	1.800	0.550		
	"			2.550	1.600	1.300	1.050	0.800	2.000	0.600		
12.	ix.	1	△	2.500	1.700	1.300	1.050	0.950	2.000	0.600	0.300	0.300
17.	ix.	1	△	2.700	1.750	1.400	1.200	0.950	1.900	0.600	0.200	0.350
Maximum				2.850	1.900	1.900	1.200	1.000	2.100	0.650	0.500	0.500
Minimum				2.150	1.200	1.000	0.600	0.750	1.000	0.250	0.200	0.200
Average				2.625	1.696	1.365	1.075	0.909	1.810	0.561	0.453	0.448

Table 129. Variation in size of eggs dropped by *Phraortes kumamotoensis* No. 48 during her life.

Date	Number	Shape	a	b	c	d	e	f	g	h	i
19. vii.	1	○	2.650	1.750	1.350	1.150	1.000	1.900	0.550	0.500	0.500
20. vii.	2	△	2.350	1.850	1.500	1.100	0.850	2.050	0.700	0.400	0.350
	"	△	2.650	1.800	1.500	1.150	0.900	2.000	0.700	0.300	0.400
21. vii.	3	○	2.600	1.750	1.250	1.150	1.000	1.600	0.600	0.500	0.500

〃		○	2.800	1.750	1.500	1.150	1.000	1.900	0.600	0.500	0.500
〃		△	2.400	1.900	1.350	1.150	0.950	2.000	0.650	0.400	0.500
23. vii.	2	○	2.500	1.750	1.500	1.100	0.900	1.500	0.650	0.550	0.500
〃		△	2.650	1.700	1.500	1.100	0.950	1.600	0.600	0.350	0.500
24. vii.	2	○	2.800	1.750	1.500	1.150	0.900	2.000	0.600	0.500	0.500
〃		△	2.650	1.800	1.500	1.200	0.950	1.900	0.650	0.350	0.450
25. vii.	2	○	2.600	1.800	1.500	1.150	0.800	1.800	0.700	0.500	0.500
〃		△	2.900	1.800	1.500	1.100	0.900	1.600	0.650	0.500	0.500
26. vii.	1	△	2.750	1.900	1.500	1.100	0.900	1.900	0.650	0.250	0.350
27. vii.	1	△	2.750	1.800	1.500	1.200	0.950	1.900	0.650	0.300	0.500
28. vii.	3	△	2.700	1.900	1.500	1.150	0.950	1.900	0.550	0.350	0.450
〃		△	2.750	1.750	1.500	1.050	0.950	1.900	0.650	0.350	0.350
〃		△	2.800	1.900	1.500	1.150	0.950	2.000	0.600	0.500	0.500
29. vii.	3	○	2.650	1.800	1.500	1.200	0.900	1.900	0.650	0.500	0.500
〃		△	2.750	1.750	1.500	1.150	0.950	1.800	0.650	0.450	0.250
〃		○	2.600	1.750	1.500	1.100	0.950	1.700	0.600	0.500	0.500
30. vii.	1	△	2.950	1.750	1.500	1.200	0.900	2.000	0.600	0.250	0.300
31. vii.	2	○	2.750	1.800	1.500	1.100	0.900	1.800	0.650	0.500	0.500
〃		○	2.550	1.750	1.500	1.100	0.900	1.750	0.650	0.500	0.500
1. viii.	2	○	2.800	1.850	1.500	1.150	0.950	2.000	0.650	0.500	0.450
〃		○	2.650	1.750	1.500	1.100	1.000	1.900	0.600	0.500	0.500
2. viii.	1	○	2.650	1.750	1.500	1.100	0.950	1.750	0.650	0.500	0.500
3. viii.	3	△	2.500	1.600	1.300	1.050	0.900	1.600	0.650	0.450	0.450
〃		△	2.650	1.650	1.300	1.100	0.800	1.900	0.650	0.350	0.300
〃		△	2.500	1.750	1.500	1.100	0.900	1.800	0.650	0.300	0.300
4. viii.	4	○	2.500	1.700	1.300	1.100	0.850	1.700	0.650	0.500	0.500
〃		△	2.500	1.650	1.350	1.100	0.850	1.650	0.600	0.300	0.300
〃		△	2.750	1.700	1.250	1.000	0.850	1.800	0.600	0.350	0.400
〃		△	2.600	1.600	1.300	1.050	0.800	1.900	0.600	0.450	0.350
5. viii.	1	○	2.500	1.500	1.150	1.000	0.850	1.800	0.600	0.500	0.450
6. viii.	3	△	2.500	1.500	1.250	1.100	0.900	1.850	0.700	0.500	0.300
〃		○	2.650	1.600	1.250	1.050	0.850	1.850	0.600	0.500	0.350
〃		△	2.650	1.650	1.250	1.050	0.850	1.750	0.600	0.250	0.250
8. viii.	2	△	2.600	1.700	1.250	1.100	0.950	1.900	0.650	0.250	0.350
〃		△	2.600	1.750	1.250	1.100	0.950	1.800	0.600	0.250	0.400
11. viii.	1	△	2.600	1.750	1.250	1.100	0.800	1.700	0.600	0.350	0.350
13. viii.	3	△	2.400	1.600	1.250	1.050	0.750	1.800	0.550	0.250	0.250
〃		△	2.550	1.600	1.400	1.050	0.800	1.650	0.650	0.300	0.250
〃		○	2.650	1.750	1.200	1.100	1.000	1.700	0.600	0.500	0.500

14.	viii.	1	○	2.500	1.700	1.300	1.100	0.750	1.850	0.600	0.500	0.450
16.	viii.	1	△	2.650	1.800	1.500	1.100	0.900	2.000	0.700	0.350	0.250
18.	viii.	1	△	2.750	1.800	1.500	1.100	0.900	1.900	0.700	0.200	0.250
24.	viii.	3	△	2.750	1.750	1.300	1.100	0.800	1.900	0.600	0.350	0.100
"			△	2.750	1.700	1.300	1.050	0.750	2.000	0.700	0.400	0.300
"			△	2.650	1.900	1.400	1.100	0.900	1.900	0.700	0.250	0.300
2.	ix.	2	△	2.750	1.700	1.500	1.200	0.950	2.000	0.650	0.300	0.250
"			△	2.650	1.750	1.500	1.100	0.950	1.900	0.650	0.300	0.300
4.	ix.	3	△	2.650	1.700	1.250	1.100	0.900	1.750	0.600	0.150	0.200
"			△	2.550	1.700	1.300	1.050	0.850	1.750	0.650	0.150	0.100
"			△	2.550	1.600	1.250	1.100	0.900	1.750	0.600	0.150	0.200
6.	ix.	1	△	2.500	1.600	1.200	1.000	0.800	1.900	0.600	0.300	0.300
7.	ix.	2		2.500	1.600	1.250	1.050	1.750	1.750	0.600		
"			△	2.500	1.550	1.250	1.050	0.800	1.950	0.650	0.300	0.350
8.	ix.	1	△	2.450	1.600	1.250	0.950	0.800	1.950	0.650	0.250	0.300
10.	ix.	1	△	2.650	1.500	1.300	0.950	1.050	2.000	0.700	0.250	0.200
17.	ix.	1	△	3.000	1.900	1.250	1.250	0.900	2.000	0.550	0.200	0.250
Maximum				3.000	1.900	1.500	1.250	1.050	2.050	0.700	0.500	0.500
Minimum				2.400	1.500	1.150	0.950	0.750	1.500	0.550	0.150	0.100
Average				2.630	1.725	1.380	1.100	0.894	1.840	0.631	0.358	0.372

Table 130. Variation in size of eggs dropped by *Phraortes kumamotoensis* No. 50 during her life.

Date	Number	Shape	a	b	c	d	e	f	g	h	i
27. vii.	1	△	2.500	1.600	1.150	1.000	0.750	1.850	0.500	0.350	0.300
4. viii.	1	△	2.400	1.750	1.300	1.050	0.700	1.500	0.550	0.400	0.300
8. viii.	1	△	2.500	1.700	1.850	1.150	0.750	1.750	0.500	0.350	0.250
9. viii.	2	△	2.650	1.750	1.250	1.200	0.300	1.800	0.550	0.250	0.350
〃		△	2.600	1.700	1.250	1.150	0.800	1.600	0.550	0.300	0.250
11. viii.	2	△	2.600	1.800	1.500	1.250	0.800	1.750	0.550	0.300	0.300
〃		△	2.500	1.800	1.500	1.200	0.800	1.600	0.550	0.400	0.300
13. viii.	1	△	2.500	1.850	1.400	1.150	0.850	1.600	0.550	0.300	0.250
14. viii.	1	△	2.600	1.750	1.300	1.500	0.900	1.850	0.500	0.500	0.350
15. viii.	1	△	2.650	1.700	1.300	1.150	0.950	1.750	0.550	0.450	0.300
21. viii.	2	△	2.500	1.750	1.450	1.000	0.950	1.750	0.550	0.400	0.350
〃		△	2.650	1.700	1.400	1.150	0.950	1.600	0.500	0.300	0.200
24. viii.	3	△	2.500	1.700	1.250	1.050	0.900	1.850	0.500	0.450	0.150

〃		○	2.700	1.750	1.250	1.200	0.850	1.800	0.550	0.500	0.350
〃		△	2.500	1.600	1.450	1.100	0.800	1.650	0.550	0.350	0.300
29. viii.	1	△	2.600	1.600	1.400	1.200	0.900	1.750	0.500	0.300	0.350
30. viii.	2	△	2.600	1.600	1.300	1.200	0.800	1.900	0.550	0.300	0.250
〃		△	2.650	1.700	1.300	1.110	0.850	1.600	0.550	0.400	0.300
1. ix.	1	△	2.600	1.750	1.400	1.150	0.900	1.650	0.550	0.350	0.300
2. ix.	1	△	2.500	1.700	1.300	1.150	0.900	1.900	0.600	0.350	0.300
3. ix.	1	△	2.600	1.750	1.500	1.100	0.850	2.000	0.600	0.350	0.250
9. ix.	1	○	2.650	1.800	1.400	1.200	0.800	1.700	0.750	0.500	0.350
10. ix.	1	△	2.700	1.750	1.400	1.250	0.800	1.850	0.550	0.350	0.200
12. ix.	1	△	2.400	1.800	1.400	1.250	0.950	1.900	0.700	0.400	0.200
13. ix.	1	△	2.250	1.500	1.400	1.150	0.900	1.900	0.750	0.450	0.200
15. ix.	1	△	2.750	1.850	1.500	1.200	1.000	2.000	0.550	0.350	0.200
17. ix.	1	△	2.550	1.900	1.500	1.300	1.000	1.700	0.550	0.300	0.300
19. ix.	3	△	2.550	1.800	1.300	1.200	0.850	1.900	0.500	0.400	0.200
〃		△	2.500	1.800	1.250	1.150	0.750	1.950	0.550	0.300	0.300
〃		△	2.500	1.800	1.500	1.200	1.000	1.700	0.550	0.400	0.300
Maximum			2.700	1.900	1.500	1.250	1.000	2.000	0.750	0.500	0.350
Minimum			2.250	1.600	1.250	1.050	0.700	1.500	0.500	0.300	0.150
Average			2.558	1.735	1.380	1.161	0.860	1.770	0.560	0.370	0.276

Table 131. Variation in size of eggs dropped by *Phraortes kumamotoensis* No. 51 during her life.

Date	Number	Shape	a	b	c	d	e	f	g	h	i
27. vii.	1	○	2.400	1.250	1.000	0.800	0.700	1.750	0.500	0.500	0.500
2. viii.	1	○	2.350	1.400	1.000	1.000	0.800	1.650	0.550	0.500	0.400
10. viii.	2	○	2.500	1.600	1.250	1.000	0.750	1.650	0.550	0.450	0.400
〃		△	2.700	1.600	1.250	1.050	0.800	1.750	0.550	0.300	0.300
12. viii.	2	△	2.550	1.500	1.100	1.000	0.750	1.800	0.500	0.300	0.350
〃		○	2.500	1.550	1.100	1.100	0.750	1.700	0.500	0.450	0.400
13. viii.	1	△	2.300	1.600	1.200	1.000	0.750	1.600	0.550	0.250	0.350
14. viii.	2	○	2.400	1.500	1.750	1.050	0.900	1.600	0.550	0.500	0.400
〃		△	2.500	1.500	1.150	0.950	0.750	1.750	0.550	0.300	0.350
15. viii.	1										
18. viii.	2	○	2.600	1.650	1.800	1.150	0.800	1.700	0.550	0.350	0.350
〃		○	2.550	1.600	1.300	1.100	0.800	1.600	0.500	0.400	0.250
19. viii.	1	△	2.500	1.550	1.250	1.100	0.850	1.650	0.550	0.300	0.300

20.	viii.	2	○	2.500	1.600	1.300	1.100	0.750	1.650	0.550	0.350	0.400
"			△	2.700	1.700	1.200	1.100	0.800	1.650	0.600	0.250	0.400
21.	viii.	2	△	2.350	1.500	1.250	1.050	0.800	1.600	0.500	0.350	0.300
"			○	2.500	1.500	1.250	1.050	0.800	1.750	0.550	0.500	0.500
22.	viii.	1	△	2.500	1.650	1.250	1.100	0.800	1.700	0.550	0.200	0.300
24.	viii.	1										
27.	viii.	2	△	2.500	1.600	1.200	1.000	0.750	1.600	0.550	0.200	0.350
"			○	2.500	1.600	1.250	1.150	0.700	1.700	0.500	0.400	0.450
29.	viii.	2		2.500	1.500	1.200	1.050	0.750	1.700	0.550		
"				2.350	1.500	1.650	1.000	0.750	1.600	0.550		
30.	viii.	1		2.300	1.700	1.250	1.100	0.800	1.600	0.550		
31.	viii.	1	△	2.500	1.650	1.200	1.050	0.800	1.900	0.550	0.200	0.300
1.	ix.	2	△	2.400	1.500	1.100	1.050	0.700	1.650	0.550	0.350	0.350
"			△	2.500	1.650	1.250	1.050	0.850	1.700	0.550	0.350	0.250
3.	ix.	1	△	2.500	1.700	1.250	1.100	0.850	1.750	0.550	0.300	0.350
4.	ix.	1	△	2.550	1.700	1.250	1.100	0.750	1.700	0.550	0.200	0.250
7.	ix.	2	△	2.250	1.550	1.250	1.100	0.750	1.550	0.500	0.200	0.200
"			△	2.450	1.600	1.250	1.050	0.700	1.650	0.500	0.350	0.250
8.	ix.	1	△	2.250	1.500	1.250	1.000	0.650	1.500	0.450	0.200	0.200
9.	ix.	1	○	2.250	1.500	1.250	1.050	0.700	1.700	0.500	0.350	0.300
10.	ix.	1	△	2.250	1.500	1.150	1.050	0.750	1.600	0.550	0.300	0.250
11.	ix.	1	○	2.250	1.500	1.100	1.000	0.700	1.500	0.500	0.350	0.300
12.	ix.	1	△	2.300	1.650	1.150	1.050	0.800	1.700	0.550	0.250	0.300
13.	ix.	2	○	2.350	1.500	1.100	1.050	0.750	1.650	0.500	0.500	0.400
"				2.000	1.200	1.000	0.900	0.550	1.250	0.350		
17.	ix.	2		2.250	1.600	1.300	1.200	0.800	1.600	0.500		
"				2.300	1.500	1.200	1.100	0.800				
19.	ix.	3	△	2.500	1.750	1.300	1.250	0.900	1.750	0.550	0.300	0.200
"			△	2.500	1.650	1.350	1.200	0.900	1.750	0.500	0.200	0.250
"			△	2.500	1.750	1.300	1.250	0.850	1.750	0.500	0.250	0.250
Maximum				2.700	1.750	1.800	1.250	0.900	1.900	0.550	0.500	0.500
Minimum				2.000	1.250	1.000	0.900	0.650	1.250	0.350	0.200	0.200
Average				2.204	1.561	1.212	1.061	0.771	1.658	0.501	0.328	0.327

Table 132. Variation in size of eggs dropped by *Phraortes kumamotoensis* No. 52 during her life.

Date	Number	Shape	a	b	c	d	e	f	g	h	i
29. vii.	1	○	2.900	1.550	1.150	1.050	0.800	1.600	0.550	0.550	0.500
14. viii.	1	×	2.900	1.750		1.100	0.800	2.000			
19. viii.	1	△	3.050	1.700	1.350	1.100	0.800	2.100	0.550	0.500	0.250
Maximum			3.050	1.750	1.100	1.100	0.800	2.100	0.550	0.550	0.500
Minimum			2.900	1.550	1.050	1.050	0.800	1.600	0.550	0.500	0.250
Average			2.950	1.666	1.250	1.083	0.800	1.900	0.550	0.525	0.375

Table 133. Variation in size of eggs dropped by *Phraortes kumamotoensis* No. 54 during her life.

Date	Number	Shape	a	b	c	d	e	f	g	h	i
24. vii.	3	○	2.750	1.750	1.500	1.250	1.000	2.000	0.550	0.550	0.500
"		△	2.900	1.800	1.350	1.200	0.900	1.800	0.500	0.500	0.500
"		△	3.000	1.750	1.300	1.250	0.800	2.050	0.550	0.500	0.450
25. vii.	1	△	2.800	1.800	1.500	1.250	1.000	1.900	0.550	0.500	0.350
26. vii.	2	△	2.850	1.750	1.400	1.250	0.850	1.800	0.550	0.500	0.500
"		△	2.900	1.750	1.500	1.200	0.850	1.950	0.550	0.500	0.500
27. vii.	3	△	2.750	1.800	1.500	1.200	0.950	1.800	0.550	0.450	0.500
"		○	2.750	1.750	1.500	1.200	0.750	1.800	0.550	0.500	0.450
"		△	2.800	1.750	1.300	1.200	0.950	1.800	0.550	0.350	0.450
28. vii.	2	△	2.700	1.750	1.500	1.250	1.000	1.900	0.500	0.500	0.500
"		△	2.600	1.800	1.450	1.200	0.800	1.900	0.500		0.450
29. vii.	1	△	2.750	1.800	1.500	1.200	0.800	1.800	0.500	0.250	0.450
30. vii.	3	△	2.700	1.750	1.400	1.200	0.900	1.750	0.550	0.450	0.450
"		△	2.700	1.750	1.450	1.250	0.900	1.900	0.500	0.300	0.450
"		△	2.700	1.750	1.500	1.200	1.000	1.800	0.500	0.500	0.450
31. vii.	2	△	2.800	1.750	1.400	1.200	0.900	1.800	0.550	0.250	0.400
"		△	2.800	1.700	1.400	1.100	0.950	2.000	0.500	0.350	0.450
1. viii.	3	△	2.800	1.750	1.400	1.200	0.900	1.850	0.550	0.300	0.350
"		○	2.750	1.700	1.300	1.200	1.000	1.850	0.550	0.550	0.450
"		△	2.700	1.750	1.450	1.150	1.000	1.800	0.550	0.300	0.450
2. viii.	3	△	2.700	1.650	1.400	1.100	0.800	1.800	0.550	0.500	0.500
"		△	2.750	1.750	1.500	1.150	0.900	1.800	0.500	0.450	0.400

"			△	2.750	1.800	1.450	1.200	0.900	1.950	0.550	0.400	0.400
3. viii.	3		○	2.500	1.750	1.300	1.150	0.950	1.750	0.550	0.500	0.500
"			△	2.650	1.750	1.450	1.250	0.850	1.800	0.550	0.500	0.450
"			△	2.600	1.750	1.300	1.250	0.900	1.800	0.550	0.300	0.450
5. viii.	1		△	2.700	1.800	1.500	1.200	0.950	1.900	0.550	0.300	0.350
6. viii.	2		△	2.750	1.750	1.450	1.250	0.950	1.750	0.550	0.400	0.300
"			△	2.750	1.750	1.300	1.250	0.950	1.900	0.550	0.300	0.300
9. viii.	3		△	2.500	1.650	1.300	1.150	0.900	1.750	0.550	0.300	0.200
"			△	2.450	1.550	1.200	1.200	0.900	1.700	0.550	0.300	0.350
"			△	2.600	1.700	1.750	1.050	0.900	1.750	0.600	0.300	0.200
10. viii.	1		△	2.600	1.500	1.100	1.000	0.800	1.650	0.500	0.300	0.200
11. viii.	4		△	2.300	1.400	1.100	1.000	0.800	1.600	0.500	0.300	0.400
"			△	2.450	1.450	1.100	1.000	0.700	1.800	0.500	0.400	0.350
"			△	2.400	1.400	1.250	0.950	0.750	1.750	0.500	0.300	0.300
"			△	2.350	1.450	1.150	1.000	0.700	1.800	0.550	0.350	0.350
12. viii.	3											
13. viii.	4		○	2.400	1.600	1.200	1.100	0.800	1.750	0.500	0.350	0.300
"			△	2.350	1.500	1.250	1.100	0.800	1.500	0.500	0.300	0.200
"			△	2.250	1.500	1.200	1.050	0.750	1.500	0.550	0.300	0.200
"			△	2.400	1.600	1.250	1.100	0.900	1.500	0.550	0.400	0.200
14. viii.	1		△	2.300	1.400	1.050	1.000	0.700	1.700	0.500	0.350	0.350
15. viii.	1		△	2.450	1.400	1.000	1.050	0.750	1.700	0.550	0.300	0.300
16. viii.	1		○	2.250	1.250	1.000	1.000	0.700	1.650	0.500	0.500	0.400
19. viii.	2		△	2.100	1.400	1.000	0.750	0.600	1.500	0.500	0.500	0.150
"			△	2.300	1.300	1.000	0.850	0.700	1.700	0.500	0.350	0.300
2. ix.	1		△	2.250	1.250	0.900	1.000	0.650	1.700	0.500	0.300	0.250
Maximum				3.000	1.800	1.750	1.250	1.000	2.000	0.600	0.550	0.500
Minimum				2.100	1.250	0.900	0.750	0.650	1.500	0.500	0.250	0.150
Average				2.603	1.631	1.320	1.134	0.854	1.780	0.529	0.390	0.356

Table 134. Variations in size of eggs dropped by *Phraortes kumamotoensis* No. 55 during her life.

Date	Number	Shape	a	b	c	d	e	f	g	h	i
22. vii	1	○	2.750	1.750	1.150	1.150	0.900	1.600	0.500	0.500	0.500
23. vii.	1	○	2.600	1.750	1.300	1.050	0.800	1.800	0.500	0.450	0.500
24. vii.	2	○	2.750	1.650	1.250	1.000	0.750	1.800	0.500	0.500	0.400

"			△	2.600	1.650	1.250	1.100	0.750	1.500	0.550	0.350	0.350
25.	vii.	1	○	2.550	1.750	1.300	1.000	0.650	1.600	0.500	0.500	0.450
26.	vii.	1	○	2.600	1.750	1.350	1.100	0.800	1.500	0.550	0.500	0.450
27.	vii.	2	△	2.750	1.700	1.450	1.100	0.850	1.600	0.450	0.500	0.350
"			△	2.600	1.700	1.350	1.150	0.850	1.800	0.550	0.500	0.450
28.	vii.	4	△	2.500	1.750	1.450	1.200	0.950	1.600	0.500	0.350	0.350
"			○	2.800	1.800	1.400	1.100	1.000	1.800	0.500	0.500	0.450
"			△	2.600	1.700	1.300	1.100	0.850	1.750	0.500	0.450	0.350
"			△	2.700	1.750	1.500	1.100	0.950	1.800	0.500	0.350	0.350
29.	vii.	2	○	2.750	1.800	1.500	1.150	1.000	1.800	0.500	0.500	0.500
"			△	2.750	1.800	1.550	1.100	0.950	2.000	0.550	0.500	0.300
30.	vii.	1	○	2.700	1.800	1.500	1.150	0.900	1.800	0.500	0.500	0.500
31.	vii.	3	○	2.750	1.750	1.450	1.200	0.950	1.750	0.550	0.500	0.300
"			△	2.750	1.800	1.500	1.150	0.950	1.700	0.550	0.300	0.400
"			△	2.850	1.800	1.450	1.100	0.900	1.750	0.500	0.350	0.500
1.	viii.	3	△	2.500	1.800	1.450	1.200	0.900	1.700	0.500	0.400	0.450
"			△	2.750	1.750	1.450	1.000	0.950	1.750	0.550		0.300
"			△	2.700	1.750	1.350	1.150	0.750	1.500	0.500	0.500	0.350
2.	viii.	2	○	2.750	1.750	1.500	1.100	0.950	1.700	0.550	0.600	0.350
"			△	2.650	1.800	1.500	1.100	0.900	1.600	0.550	0.500	0.450
3.	viii.	2	△	2.750	1.750	1.300	1.100	0.900	1.600	0.550	0.300	0.350
"			○	2.600	1.700	1.350	1.100	0.950	1.750	0.500	0.650	0.350
4.	viii.	1	○	2.750	1.700	1.300	1.050	0.900	1.750	0.500	0.550	0.350
Maximum				2.850	1.800	1.550	1.200	1.000	2.000	0.550	0.650	0.500
Minimum				2.500	1.650	1.250	1.000	0.650	1.500	0.450	0.300	0.300
Average				2.692	1.748	1.392	1.107	0.882	1.703	0.517	0.382	0.403

Table 135. Variation in size of eggs dropped by *Phraortes kumamotoensis* No. 56 during her life.

Date	Number	Shape	a	b	c	d	e	f	g	h	i	
26.	vii.	1	△	3.000	1.650	1.300	1.000	0.800	1.750	0.550	0.350	0.450
27.	vii.	3	○	2.900	1.750	1.500	1.000	0.800	1.800	0.500	0.490	0.400
"		△	2.600	1.750	1.300	1.100	0.800	2.050	0.500			0.350
"		○	3.000	1.750	1.400	1.100	0.900	1.900	0.500	0.500		0.450
29.	vii.	3	○	3.000	1.800	1.500	1.050	0.900	1.800	0.550	0.500	0.500
"		△	3.000	1.800	1.500	1.050	0.850	1.750	0.550	0.400		0.400
"		△	2.650	1.800	1.500	1.250	1.000	1.850	0.550			0.400

3. viii.	2	○	3.000	1.900	1.500	1.100	0.850	0.900	0.550	0.450	0.500
"		△	3.000	1.850	1.550	1.100	0.850	1.800	0.550		0.450
5 viii.	2	○	3.000	1.700	1.450	1.000	0.800	1.800	0.500		
"		△	3.000	1.700	1.400	1.050	0.750	1.800	0.500	0.350	0.350
6. viii.	2	○	2.800	1.700	1.450	1.000	0.800	1.750	0.500	0.400	0.250
"		△	2.900	1.500	1.250	1.000	0.800	1.800	0.500		0.250
7. viii.	1	△	2.500	1.500	1.200	0.900	0.750	1.550	0.450	0.500	0.250
Maximum			3.000	1.900	1.550	1.250	1.000	2.050	0.550	0.500	0.500
Minimum			2.500	1.500	1.200	0.900	0.750	1.550	0.450	0.350	0.250
Average			2.882	1.725	1.410	1.050	0.832	1.807	0.517	0.433	0.384

Table 136. Variation in size of eggs dropped by *Phraortes kumamotoensis* No. 57 during her life.

Date	Number	Shape	a	b	c	d	e	f	g	h	i
23. vii.	1	○	2.500	1.650	1.250	1.050	0.800	1.750	0.550	0.500	0.450
24. vii.	1	○	2.500	1.900	1.250	1.100	0.900	1.700	0.600	0.500	0.400
25. vii.	3	○	2.750	1.750	1.350	1.050	1.300	1.750	0.550	0.450	0.300
"		○	2.700	1.500	1.300	1.100	0.800	1.500	0.550	0.500	0.350
"		○	2.500	1.650	1.400	1.050	0.850	1.700	0.550	0.400	0.300
26. vii.	2	○	2.700	1.700	1.300	1.100	0.850	1.700	0.600	0.500	0.350
"		○	2.650	1.650	1.400	1.050	0.850	1.700	0.600	0.450	0.350
27. vii.	2	○	2.700	1.750	1.300	1.100	0.900	1.650	0.550	0.450	0.300
"			2.600	1.650	1.400	1.050	0.850	1.700	0.550		
28. vii.	2	○	2.750	1.800	1.300	1.100	0.750	1.800	0.600	0.500	0.350
"		○	2.700	1.750	1.500	1.050	0.800	1.800	0.550	0.450	0.350
29. vii.	1	○	2.650	1.800	1.500	1.100	0.900	1.750	0.600	0.500	0.450
30. vii.	2	○	2.750	1.750	1.500	1.100	0.900	1.700	0.550	0.450	0.300
"		△	2.750	1.850	1.450	1.150	0.900	1.750	0.550	0.450	0.350
31. vii.	4	○	2.700	1.700	1.400	1.100	0.950	1.650	0.500	0.450	0.350
"		△	2.650	1.800	1.500	1.100	0.900	1.650	0.550	0.350	0.350
"		○	2.750	1.800	1.500	1.100	0.850	1.750	0.550	0.450	0.350
"		○	2.700	1.800	1.500	1.100	0.900	1.750	0.550	0.400	0.350
2. viii.	1	○	2.750	1.800	1.500	1.050	0.850	1.750	0.550	0.400	0.350
3. viii.	3	○	2.750	1.750	1.500	1.100	0.900	1.900	0.550	0.450	0.400
"		△	2.750	1.750	1.500	1.100	0.900	1.700	0.600	0.300	0.250
"			2.700	1.750	1.300	1.050	0.850	1.750	0.550		
4. viii.	1	○	2.700	1.750	1.500	1.050	0.800	1.850	0.600	0.500	0.450

5. viii.	1	△	2.700	1.700	1.250	1.100	0.850	1.750	0.550	0.350	0.250
6. viii.	1	○	2.600	1.600	1.400	1.050	0.900	1.750	0.600	0.350	0.300
7. viii.	3	△	2.500	1.600	1.300	1.100	0.950	1.700	0.550	0.350	0.250
"		△	2.600	1.650	1.300	1.050	0.900	1.600	0.550	0.350	0.250
"		△	2.500	1.650	1.300	1.000	0.850	1.650	0.550	0.300	0.250
8. viii.	3	○	2.450	1.650	1.250	1.000	0.800	1.650	0.550	0.400	0.400
"		△	2.600	1.650	1.300	1.000	0.850	1.750	0.550	0.500	0.350
"		△	2.500	1.700	1.300	1.050	0.900	1.050	0.550	0.350	0.250
9. viii.	2	○	2.600	1.600	1.300	1.000	0.800	1.750	0.550	0.450	0.450
"		○	2.650	1.700	1.400	1.050	0.800	1.700	0.600	0.500	0.400
10. viii.	1	○	2.500	1.700	1.400	1.050	0.850	1.700	0.600	0.500	0.350
11. viii.	2	○	2.500	1.700	1.300	1.050	0.900	1.700	0.600	0.450	0.350
"		○	2.500	1.700	1.350	1.050	0.900	1.700	0.600	0.500	0.400
17. viii.	1	○	2.400	1.600	1.100	1.000	0.700	1.500	0.500	0.350	0.350
18. viii.	1	△	2.300	1.400	1.200	1.050	0.750	1.500	0.550	0.250	0.250
20. viii.	1		2.900	1.750	1.500	1.250	0.900	2.000	0.550		
22. viii.	2	△	2.500	1.500	1.150	1.000	0.750	1.500	0.500	0.450	0.250
"		○	2.500	1.550	1.200	1.000	0.750	1.550	0.550	0.450	0.300
23. viii.	1	△	2.500	1.550	1.050	1.000	0.700	1.500	0.550	0.500	0.200
24. viii.	1		2.150	1.500	1.100	1.000	0.750	1.600	0.550		
Maximum			2.750	1.900	1.500	1.250	1.300	2.000	0.600	0.500	0.450
Minimum			2.150	1.400	1.050	1.000	0.700	1.500	0.500	0.250	0.200
Average			2.593	1.686	1.345	1.063	0.855	1.640	0.564	0.429	0.334

Table 137. Variation in size of eggs dropped by *Phraortes kumamotoensis* No. 58 during her life.

Date	Number	Shape	a	b	c	d	e	f	g	h	i
26. vii.	1	△	2.650	1.700	1.400	1.200	0.950	1.750	0.550		0.450
1. viii.	1	○	2.700	1.800	1.500	1.050	0.900	1.700	0.500	0.350	0.400
7. viii.	1	△	2.700	1.600	1.200	1.200	0.650	1.800	0.500		0.250
Maximum			2.700	1.800	1.500	1.200	0.950	1.800	0.550		0.450
Minimum			2.650	1.600	1.200	1.050	0.650	1.700	0.500		0.250
Average			2.683	1.700	1.386	1.150	0.833	1.750	0.518	0.550	0.363

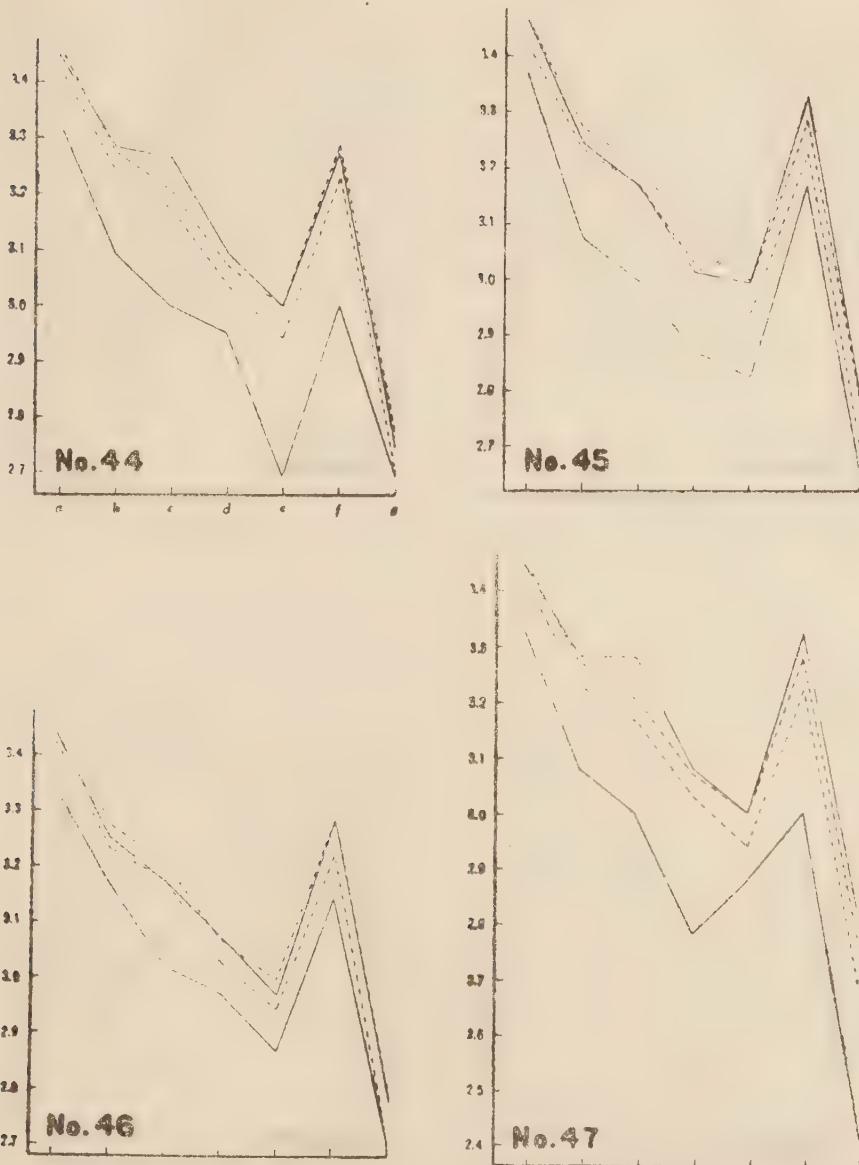
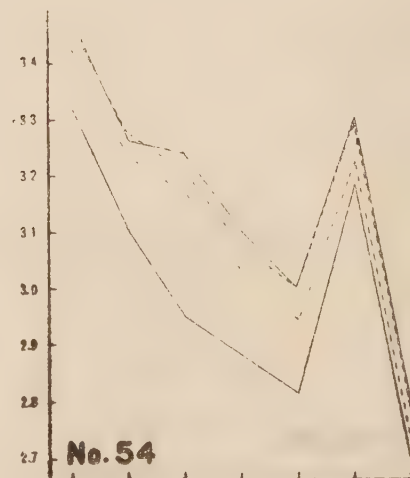
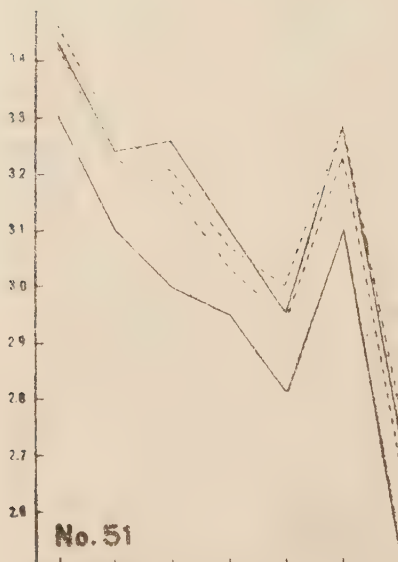
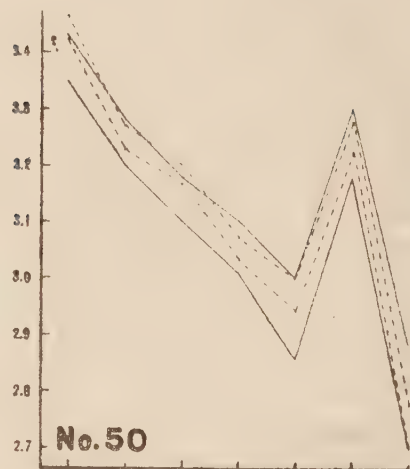
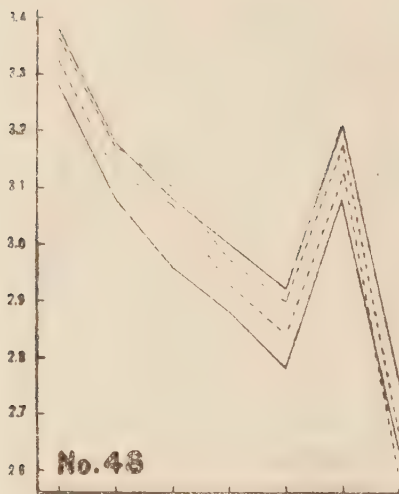
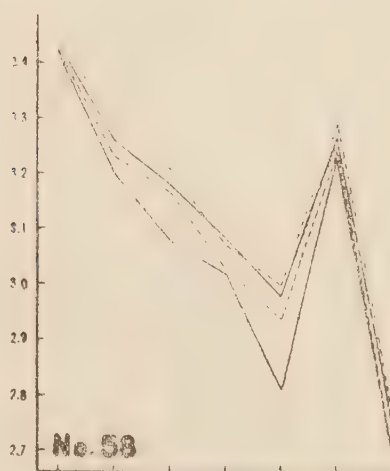
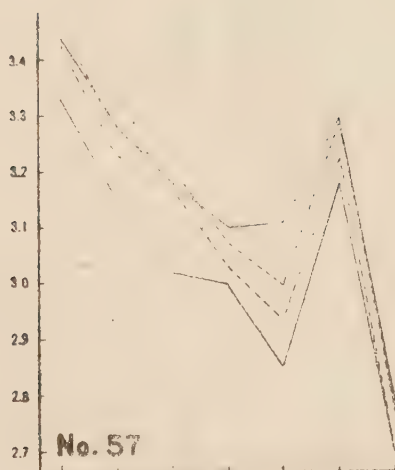
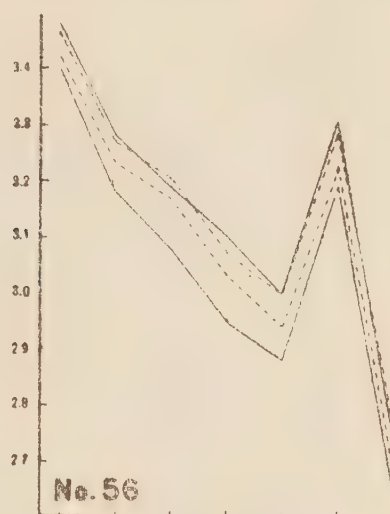
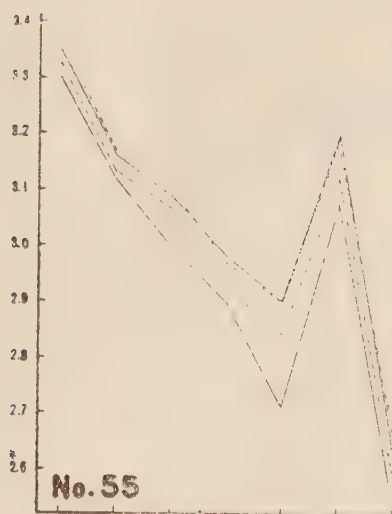


Fig. 36. Variation in size of eggs dropped by experimental and standard insects. Broken lines indicate the variation area of the standard insect. Full lines indicate the variation area of experimental insects. Abscissa represents the measured parts as given in Fig. No. 44. Ordinate represents the logarithms of $\{(values\ of\ the\ measured\ parts) \times 100\}$.





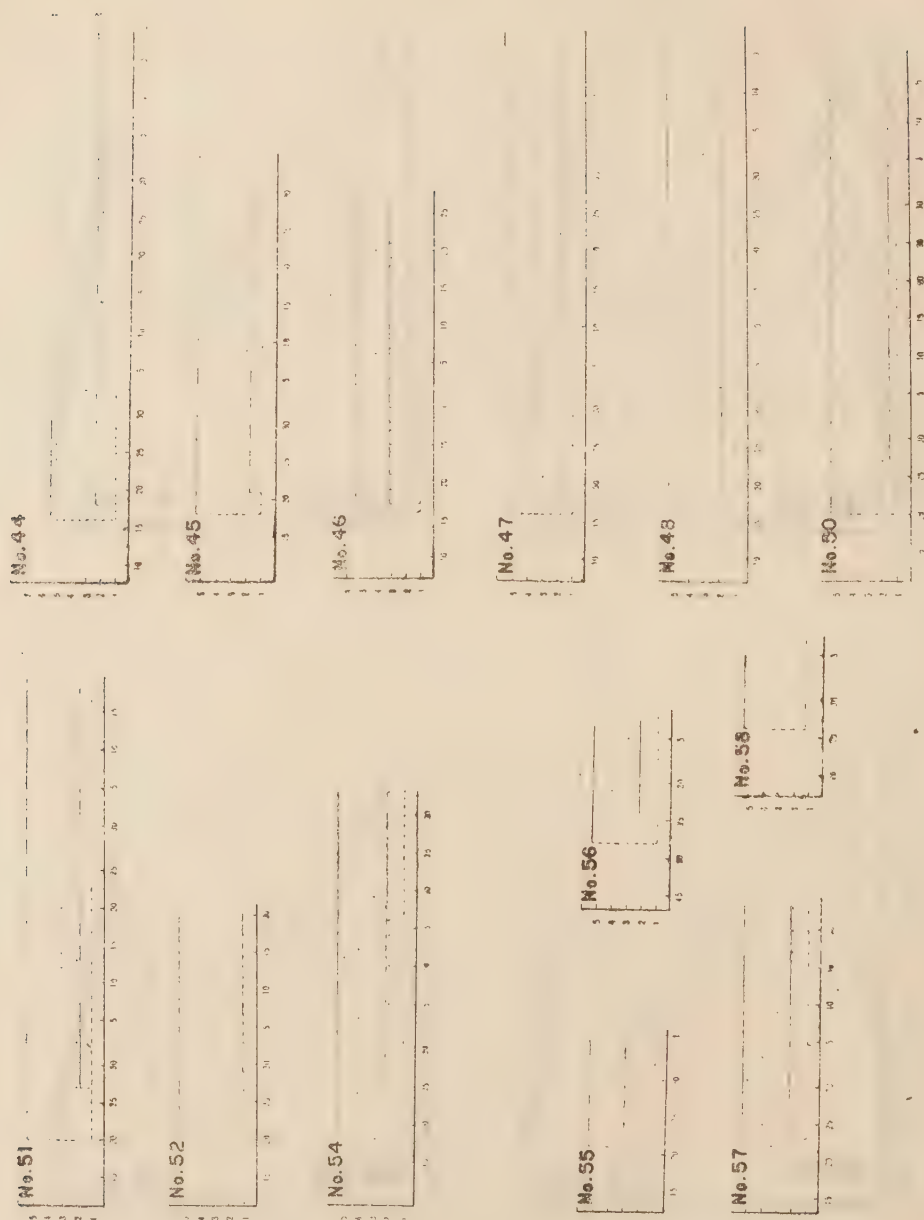


Fig. 37. Comparison of the number of eggs produced by experimental and standard insects in their oviposition period. Abscissa represents the time. Ordinate represents the number of eggs produced per day. S: Standard line of egg-production per day. E: Average line of egg-production per day in experiments. Dots represent the actual number of eggs.

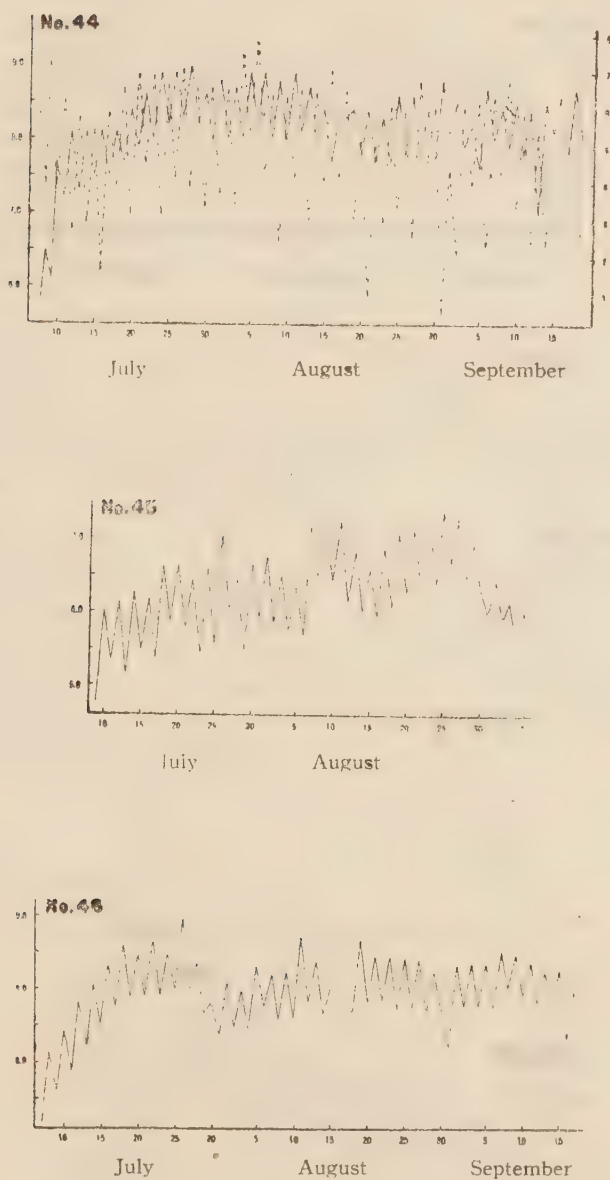
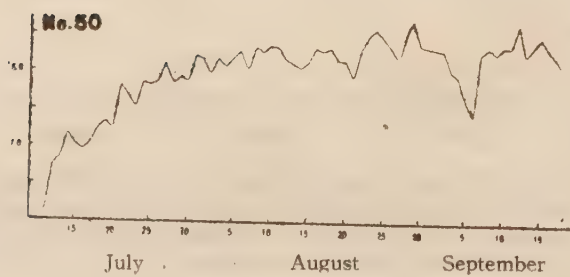
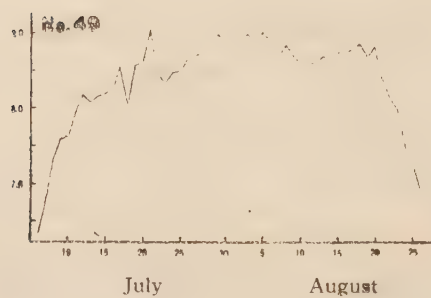
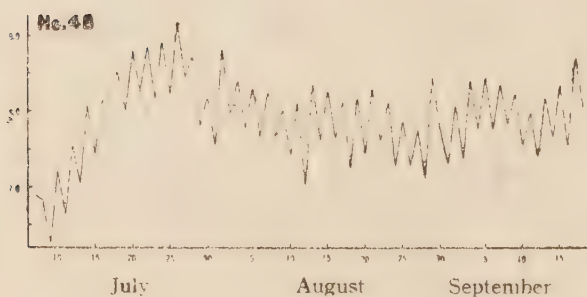
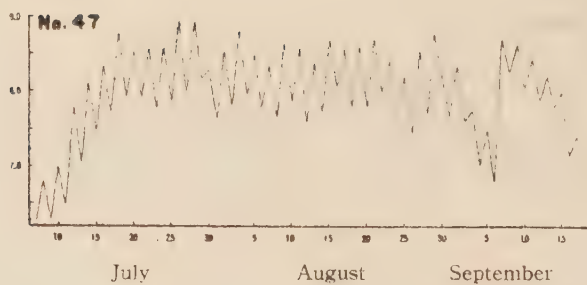
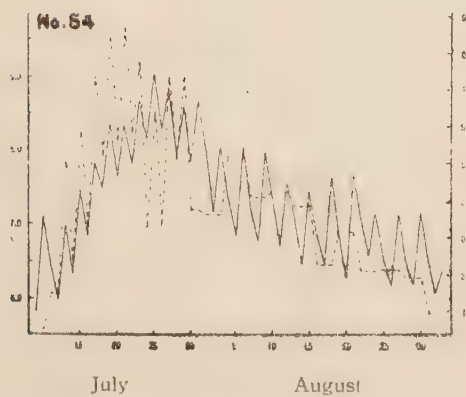
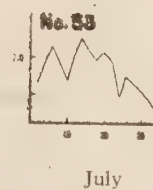
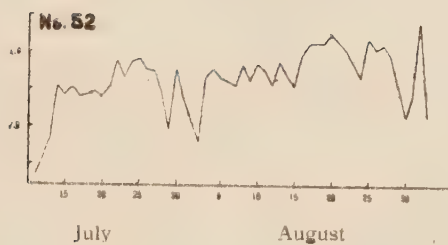
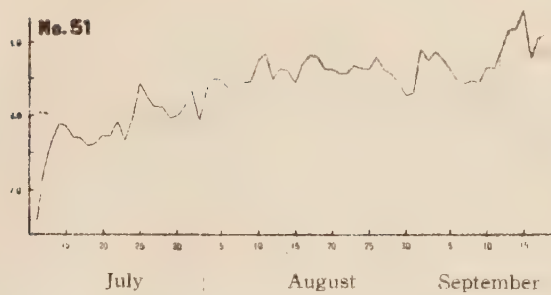


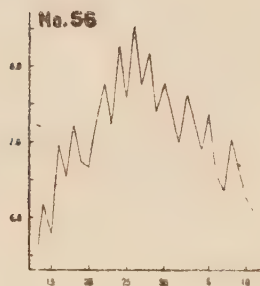
Fig. 38. Change in weight of (full line) and the volume of leaves eaten by (broken line) *Phyaortes kumamotoensis* during larval and adult stadia. Abscissa represents the date. Ordinate indicates the logarithm of the body weight or the logarithm of the volume of leaves



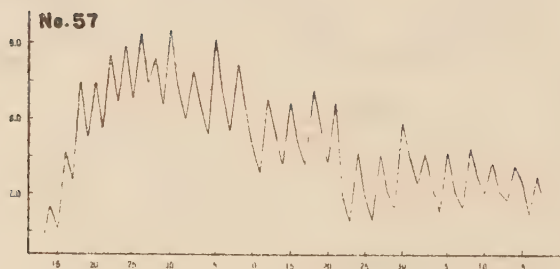




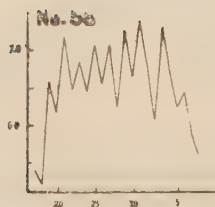
July



July August



July August September



July

Observations

From the three series of feeding experiments mentioned above, we can safely derive the following results concerning the ability of oviposition of the female sex. First of all the influence of feeding with insufficient diet upon the length of the preoviposition period must be considered. The comparatively long preoviposition period of more than 15 days appears to show that the development of the genital organs in the female sex is apparently dependent on the amount of food which will be consumed during that period. However, the preoviposition period of less than 13 days more abundant in my experiments and this may be regarded as normal as compared with that of insects reared with normal food, or in such cases the insufficient nutrition, as being fed every other day, every second days or once a day, did not influence the preoviposition period of the insects in any way without affecting the characteristic velocity of sexual maturity. In the case of the experimental insect No. 58 which was fed once a day the preoviposition period lasted only 9 days, even one day shorter than the average 10 days. Thus it is clear that the relation between the food consumption (in the cases of my experiments) and the oviposition cannot be adequately expressed by measuring the the length of the preoviposition period.

Table 138. Preoviposition period and the duration of life of the experimental insects.

No.	Preoviposition period		Duration of life in the adult stage
	Experimental	Control (Average)	
44	12 days	10 days	75 days
45	12 days	10 days	60 days
46	10 days	10 days	74 days
47	12 days	10 days	74 days
48	12 days	10 days	74 days
49	11 days	10 days	52 days
50	16 days	10 days	70 days
51	16 days	10 days	70 days
52	18 days	10 days	54 days

53	Over 6 days	10 days	16 days
54	15 days	10 days	56 days
55	10 days	10 days	26 days
56	13 days	10 days	30 days
57	10 days	10 days	18 days
58	9 days	10 days	23 days

Next it is of interest to ascertain whether insects which have been fed on an insufficient diet after the last moult are able to produce a normal number of eggs or eggs with normal shape. It has already been shown that the normal female deposits the average number of 4.5 eggs a day. The results of my experiments are clearly shown in the following table.

Table 139. Average number of eggs deposited per day by experimental insects. $R = C - E$.

No.	E (Experimental)	C (Control or normal average)	R
44	1.37	4.5	3.28
45	0.75	4.5	6.00
46	2.05	4.5	2.19
47	0.96	4.5	4.68
48	0.98	4.5	4.59
50	0.54	4.5	8.33
51	0.78	4.5	5.76
52	0.14	4.5	32.14
54	1.21	4.5	3.71
55	1.85	4.5	2.43
56	1.07	4.5	4.20
57	1.30	4.5	3.46
58	0.23	4.5	19.56

The total number of eggs produced by each of the experimental insects was not more than 100 during her life and apparently very small as compared with the case of those fed on normal diet. This result supports the fact that the insufficient nutrition of the experiments arrests the normal development of

the genital organs, especially of ovaries, from the continuous production of eggs during her life. This is also in close connection with the comparatively shorter duration of life of the adult stage. As is seen in the table given above, the average number of eggs produced per day by experimental insects is conspicuously small without exceptions. In the experiment insect No. 52 the average number of eggs produced per day was only one thirty-second of the average number in normal individuals. There were no experimental insects which could produce eggs more than a half the number of eggs of normal individuals.

Apart from the number of eggs the shape of eggs produced by experimental insects fed on an insufficient diet is to be examined. From the morphological point of view I classified the shape of the capitulum in three categories: 1—egg with a capitulum normal (○), 2—egg with a capitulum moderately deformed (△), 3—egg with a capitulum strongly deformed or without a capitulum (×). Following this classification the shapes of the capitulum of eggs deposited by experimental insects were summarized as in the following table.

Table 140. The shapes of the capitulum of eggs in experimental insects (figures in %).

Type	○		△		×	
No.	Exp.	Control	Exp.	Control	Exp.	Control
44	4.5	68.0	62.5	13.0	33.0	19.0
45	23.5	68.0	64.7	13.0	11.8	19.0
46	20.2	68.0	78.6	13.0	1.2	19.0
47	42.4	68.0	44.1	13.0	13.5	19.0
48	30.0	68.0	68.3	13.0	1.7	19.0
50	6.7	68.0	93.3	13.0	0.0	19.0
51	30.2	68.0	51.1	13.0	18.7	19.0
52	33.3	68.0	33.3	13.0	33.3	19.0
54	12.0	68.0	82.0	13.0	6.0	19.0
55	46.2	68.0	53.8	13.0	0.0	19.0
56	14.4	68.0	57.1	13.0	28.5	19.0
57	65.1	68.0	25.6	13.0	9.3	19.0
58	33.3	68.0	66.6	13.0	0.0	19.0

The above observations show that the percentage of the eggs with a normal capitulum in experimental insects is always and definitely lower than that of normal individuals, and that of the eggs with a moderately deformed capitulum is always and definitely higher than that of normal ones. The physiological nature of the process producing eggs with a strongly or moderately deformed capitulum or without a capitulum could be definitely shown only by actual analyses of several series of my experiments. In general a normally fed insect always produces eggs with a complete capitulum without exceptions. The maximum case of the production of deformed eggs was exhibited by the experimental insect No. 44, of which about 95.5 per cent of the eggs produced were with a deformed capitulum. Thus it is quite evident that the insufficient diet during the oviposition period exhibits a great effect in producing perfect eggs. Though the shape of the capitulum is independent of the hatching of eggs, it is frequently closely correlated with the shape of the capsule, a main part of the egg, and provides a good criterion in determining the adequate amount of food to produce perfect eggs. It must not be forgotten that an egg with a deformed capsule always has a deformed capitulum. The shape of the capsule is also strikingly influenced by the insufficient nutrition and those the measurements of the same in the experimental insects are given in the following table.

Table 141. The shape of the capsule of eggs produced by experimental insects.

No.	a : b	a : f	b : c	d : e
44	1.53	1.58	1.23	1.32
45	1.65	1.46	1.32	1.18
46	1.59	1.45	1.25	1.24
47	1.54	1.45	1.24	1.18
48	1.52	1.42	1.25	1.23
50	1.47	1.44	1.25	1.35
51	1.41	1.32	1.28	1.37
52	1.77	1.55	1.33	1.35
54	1.59	1.45	1.23	1.32
55	1.54	1.58	1.25	1.25
56	1.67	1.59	1.22	1.26
57	1.53	1.58	1.25	1.24
58	1.58	1.53	1.22	1.38

As shown in the text-figures, the width of the variation in the shape of eggs dropped by experimental insects fed on insufficient diet is very much larger than that in normal individuals. The value $a:b$ fluctuates between 1.41 and 1.77. In case that the value $a:b$ is small, the egg has a comparatively short capsule. The value $a:f$ fluctuates between 1.32 and 1.59. In case that the value $a:f$ is large, then the egg has a comparatively short ovary attachment. The value $a:b$ is not equal to that of $a:f$ in experimental insects, while it is not the case in normal insects. The value $b:c$ varies between 1.22 and 1.33. In case that the value $b:c$ is large, then the transverse section of the egg takes the form of a compressed ellipse. The value $d:e$ varies between 1.18 and 1.38. In case that the value $d:e$ is small, then the shape of the platform of the egg becomes semicircular in outline. In the perfect egg the values $b:c$ and $d:e$ are equal to each other. But this relation cannot be applicable to the eggs produced in my experiment. These observations allow to consider the insufficient diet experimented as being extremely resistant to the production of perfect or normally shaped eggs. Finally, in order to ascertain, if the shape of eggs dropped by experimental insects has any relationship with the age of insects, the whole oviposition period was divided into several intervals in order and the average value of eggs dropped in each division was calculated. The results of the experimental insect No. 44 are shown in the following tables. The negative result, however, that the shape of eggs dropped by ill-fed insects was independent of the age of the material, was obtained in all the cases.

Table 142. The measurements of eggs laid by experimental insect No. 44 in 7 divisions. I (Average value)

Divisions	a	b	c	d	e	f
I (18. vii - 27. vii)	2.530	1.488	1.307	1.046	0.788	1.607
II (28. vii - 6. viii)	2.600	1.720	1.443	1.145	0.886	1.618
III (7. viii - 16. viii)	2.606	1.690	1.400	1.100	0.870	1.600
IV (17. viii - 26. viii)	2.490	1.603	1.256	1.083	0.803	1.543
V (27. viii - 5. ix)	2.540	1.685	1.326	1.100	0.815	1.560
VI (6. ix - 15. ix)	2.500	1.683	1.350	1.066	0.766	1.716
VII (16. ix - 19. ix)	2.691	1.600	1.350	1.141	0.800	1.600

Table 143. The measurements of eggs laid by experimental insect No. 44 in 7 divisions. II

Divisions	a : b	a : f	b : c	d : e
I	1.70	1.57	1.13	1.32
II	1.51	1.60	1.19	1.29
III	1.54	1.62	1.20	1.26
IV	1.55	1.67	1.27	1.34
V	1.50	1.69	1.27	1.34
VI	1.48	1.45	1.24	1.39
VII	1.68	1.48	1.18	1.42

5. Experiments Series 5

Experiments Class 11

No. 59, ♀ An insect, underwent the fourth moult on June 9th, was then put immediately on this experiment. This insect underwent the fifth and sixth moults on June 19th and on July 3rd respectively. The food consumed by this insect in the sixth stadium was about twice as much as that in the fifth one. After a preoviposition period of 10 days, the first oviposition took place on July 13th. After 128 days the insect died on November 17th. Thus the duration of adult life of this female was 138 days.

No. 60, ♀ An insect, underwent the fourth moult on June 9th, was used in this experiment immediately after the moult. This insect underwent the fifth and sixth moults on June 20th and on July 4th respectively. The food taken by this insect in the sixth stadium was approximately twice as much as that in the fifth one. After a preoviposition period of 11 days, the insect laid a first egg on July 15th. After 103 days later this insect died on October 25th. Thus the duration of adult life of this female was 114 days.

No. 61, ♀ An insect, underwent the fifth moult on June 15th, was then used immediately in this experiment. After 13 days the sixth moult took place on June 28th. The preoviposition period of this female was 10 days. On September 26th the insect died 90 days after the last moult.

No. 62, ♀ An insect, underwent the fourth moult on June 21st, was used at once in this experiment. This insect underwent the

fifth and sixth moults on July 2nd and on July 13th respectively. The food consumed by this insect in the sixth stadium was exactly twice as much as that in the fifth one. After a preoviposition period of 7 days, the first oviposition took place on July 21st. After 117 days this insect died on November 14. Thus the duration of adult life of this female was 124 days.

No. 63, ♀ An insect, underwent the fourth moult on June 14th, was put immediately on this experiment. On July 25th it died during the succeeding moult.

Experiments Class 12

No. 64, ♂ An insect, underwent the fourth moult on June 11th, was used at once in this experiment. The fifth or the last moult took place on June 23rd. The duration of adult life of this male was 147 days. It died on November 17th.

No. 65, ♂ An insect, underwent the fourth moult on June 11th, was put at once on this experiment. It died on June 22nd during the final moult.

No. 66, ♂ An insect, underwent the fourth moult on June 13th, was then used immediately in this experiment. After 9 days the last moult took place on June 21st. After a long period of 141 days this male died on November 9th.

No. 67, ♂ An insect, underwent the fourth moult on June 11th, was then put immediately on this experiment. After 11 days this insect underwent the last moult on June 21st. The duration of adult life of this male was comparatively short. Thus it died on August 26th or 66 days after the final moult.

No. 68, ♂ An insect, underwent the fourth moult on June 11th, was put at once on this experiment. After 13 days this insect underwent the fifth moult. The duration of adult life of this male was very long. Thus it died on November 30th, 160 days after the last moult.

Table 144. Amount of leaves eaten by *Phraortes kumamotoensis* No. 59 in larval and adult stages.

Date	V	O	W	Date	V	O	W
9. vi.	80.0	568	920	29. viii.	344.0	2442	3956

10. vi.	150.0	1065	1725	30. viii.	174.6	1240	2008
11. vi.	188.7	1340	2170	31. viii.	362.0	2570	4163
12. vi.	293.0	2080	3370	1. ix.	550.0	3905	6325
13. vi.	183.4	1302	2109	2. ix.	613.7	4357	7058
14. vi.	272.5	1935	3134	3. ix.	503.0	3571	5785
15. vi.	228.0	1619	2622	4. ix.	325.0	2308	3738
16. vi.	290.5	2063	3341	5. ix.	278.0	1974	3197
17. vi.	0.0	0	0	6. ix.	324.5	2304	3732
18. vi.	0.0	0	0	7. ix.	174.8	1241	2010
19. vi.	0.0	0	0	8. ix.	668.0	4743	7682
20. vi.	186.4	1323	2144	9. ix.	438.5	3113	5043
21. vi.	357.6	2539	4112	10. ix.	334.0	2371	3841
22. vi.	283.0	2009	3255	11. ix.	427.2	3033	4913
23. vi.	427.0	3032	4911	12. ix.	226.0	1605	2599
24. vi.	250.0	1775	2875	13. ix.	492.0	3493	5658
25. vi.	438.6	3114	5044	14. ix.	276.5	1963	3180
26. vi.	494.3	3510	5684	15. ix.	285.2	2025	3280
27. vi.	295.2	2096	3395	16. ix.	190.0	1349	2185
28. vi.	352.0	2499	4048	17. ix.	390.0	2769	4485
29. vi.	441.5	3135	5077	18. ix.	387.6	2751	4457
30. vi.	97.0	689	1161	9. ix.	529.0	3756	6084
1. vii.	130.0	923	1495	20. ix.	409.4	2907	4708
2. vii.	0.0	0	0	21. ix.	479.0	3401	5509
3. vii.	0.0	0	0	22. ix.	251.5	1786	2892
4. vii.	201.5	1431	2317	23. ix.	419.3	2977	4922
5. vii.	396.0	2812	4554	24. ix.	264.0	2584	4181
6. vii.	708.2	5028	8144	25. ix.	113.7	807	1308
7. vii.	421.0	2989	4842	26. ix.	198.4	1409	2281
8. vii.	338.5	2403	3893	27. ix.	177.8	1262	2045
9. vii.	930.0	6603	10695	28. ix.	428.0	3039	4922
10. vii.	563.6	4002	6481	29. ix.	182.5	1296	2099
11. vii.	442.0	3138	5083	30. ix.	322.2	2288	3705
12. vii.	616.0	4374	7084	1. x.	354.0	2513	4071
13. vii.	705.0	5006	8108	2. x.	434.6	3086	4998
14. vii.	974.7	6920	11209	3. x.	222.0	1576	2553
15. vii.	1028.0	7299	11822	4. x.	133.4	947	1534
16. vii.	709.8	5040	8163	5. x.	0.0	0	0
17. vii.	867.5	6159	9976	6. x.	154.0	1093	1771
18. vii.	781.0	5545	8982	7. x.	271.5	1928	3122

19. vii.	608.0	4317	6992	8. x.	85.0	604	978
20. vii.	208.5	1480	2398	9. x.	230.0	1633	2645
21. vii.	535.6	3803	6159	10. x.	0.0	0	0
22. vii.	548.7	3896	6310	11. x.	294.0	2087	3381
23. vii.	302.0	2144	3473	12. x.	147.8	1049	1700
24. vii.	788.0	5595	9062	13. x.	222.0	1576	2553
25. vii.	409.5	2907	4709	14. x.	265.9	1888	3058
26. vii.	597.2	4240	6868	15. x.	244.0	1732	2806
27. vii.	706.0	5012	8119	16. x.	180.4	1281	2075
28. vii.	434.6	3086	4498	17. x.	145.6	1034	1674
29. vii.	650.0	4615	7475	18. x.	123.0	873	1415
30. vii.	349.7	2483	4022	19. x.	198.5	1409	2283
31. vii.	893.0	6340	10269	20. x.	361.0	2563	4152
1. viii.	517.4	3674	5950	21. x.	194.0	1377	2231
2. viii.	397.0	2819	4566	22. x.	405.6	2880	4661
3. viii.	666.5	4732	7665	23. x.	0.0	0	0
4. viii.	221.8	1575	2551	24. x.	216.0	1534	2484
5. viii.	338.0	2400	3887	25. x.	229.7	1631	2641
6. viii.	331.5	2354	3812	26. x.	94.0	667	1081
7. viii.	315.0	2237	3623	27. x.	0.0	0	0
8. viii.	781.4	5548	8986	28. x.	260.0	1846	2990
9. viii.	298.6	2120	3434	29. x.	0.0	0	0
10. viii.	369.0	2620	4244	30. x.	429.8	3052	4943
11. viii.	137.0	972	1575	31. x.	0.0	0	0
12. viii.	637.0	4523	7326	1. xi.	550.0	355	575
13. viii.	339.0	2407	2899	2. xi.	36.4	258	419
14. viii.	464.0	3294	5336	3. xi.	0.0	0	0
15. viii.	427.8	3038	4920	4. xi.	78.0	554	897
16. viii.	757.0	5375	8706	5. xi.	115.9	823	1323
17. viii.	407.5	2893	4686	6. xi.	100.0	710	1150
18. viii.	0.0	0	0	7. xi.	109.4	777	1258
19. viii.	591.0	4196	6797	8. xi.	52.3	371	601
20. viii.	513.6	3647	5906	9. xi.	53.5	380	615
21. viii.	314.0	2229	3611	10. xi.	104.0	738	1196
22. viii.	228.0	1619	2622	11. xi.	168.8	1198	1941
23. viii.	90.5	643	1041	12. xi.	41.0	291	472
24. viii.	700.0	4970	8050	13. xi.	45.7	324	526
25. viii.	943.0	6695	10845	14. xi.	69.0	490	794
26. viii.	377.3	2679	4339	15. xi.	112.0	795	1288
27. viii.	233.0	1654	2680	16. xi.	87.5	621	1006
28. viii.	347.5	2467	3996	17. xi.	93.4	663	1074

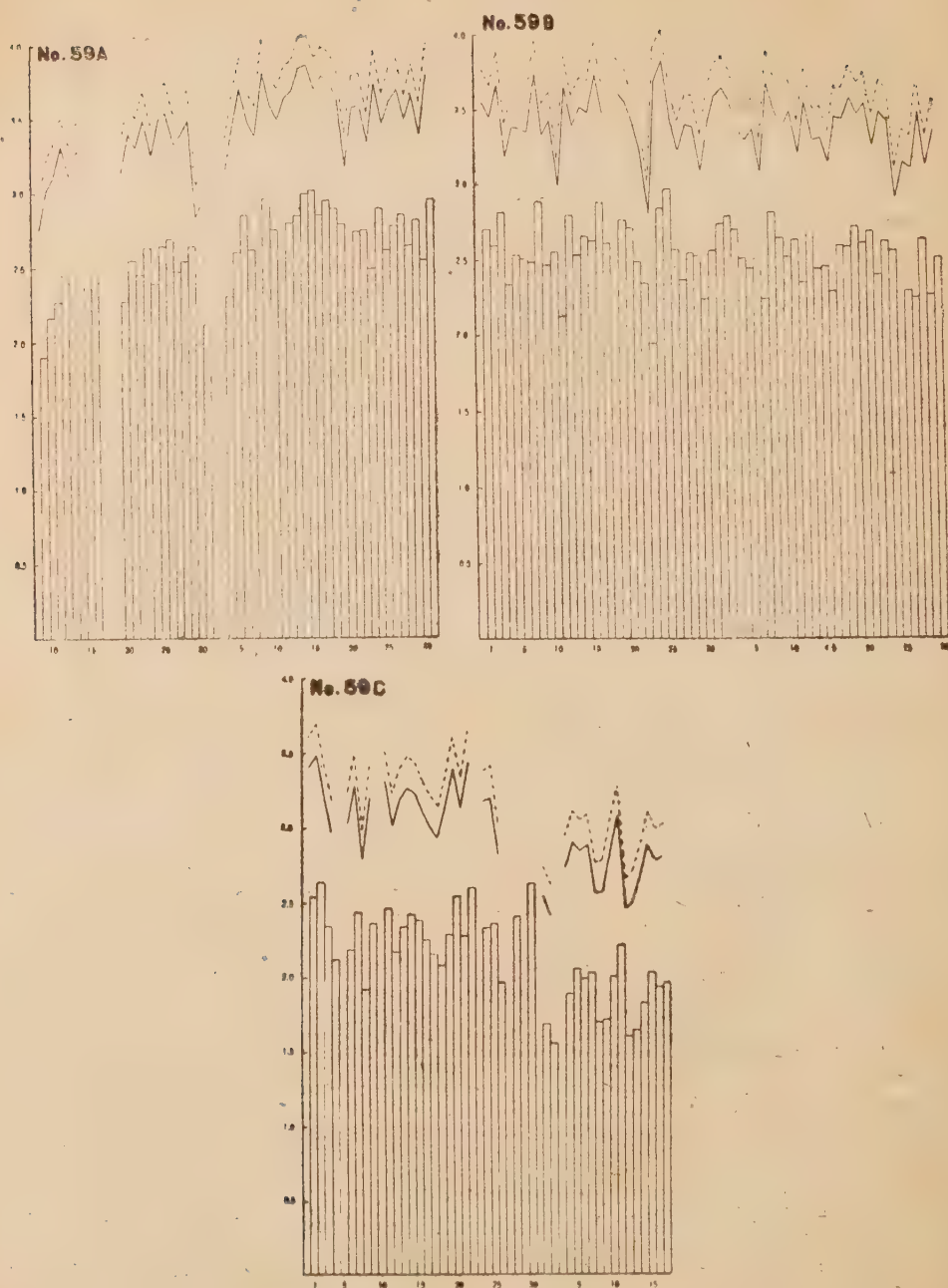


Fig. 39. Amount of leaves eaten by *Phraortes kumamotoensis*, No. 59, during the later larval and adult stadia. Abscissa represents time in date from June to November.

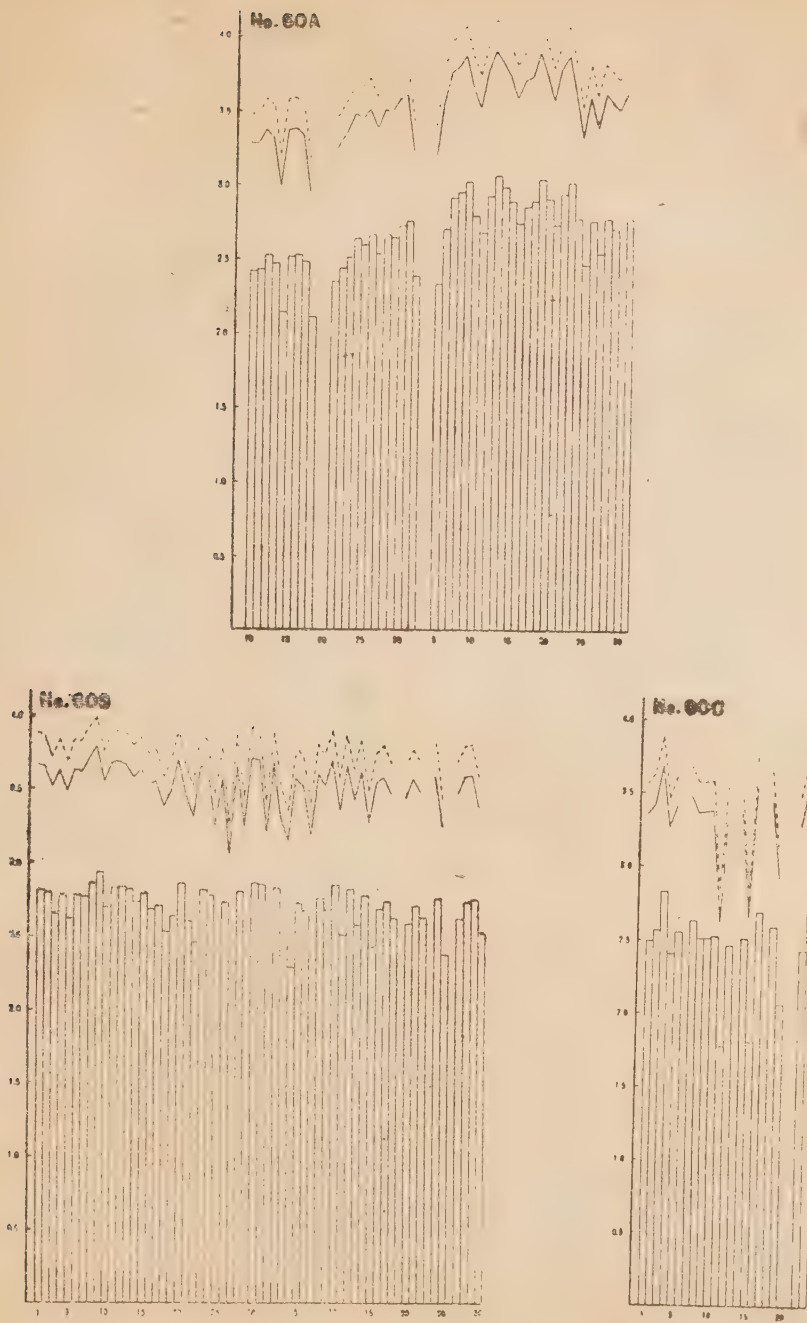


Fig. 40. Amount of leaves eaten by *Phraortes kumamotoensis*, No. 60, during the later larval and adult stadia. Abscissa represents time in date from June to October.

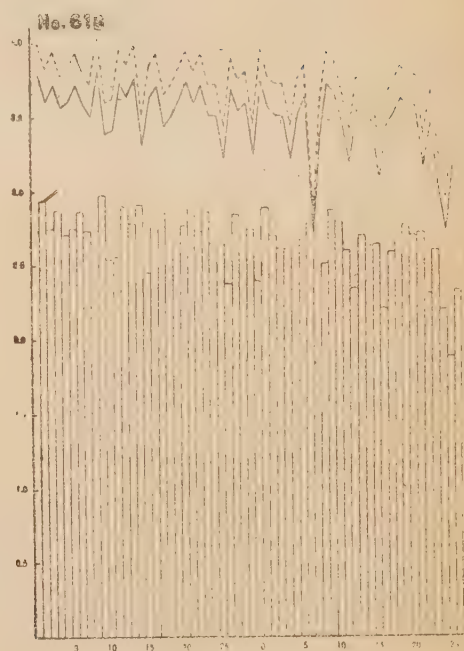
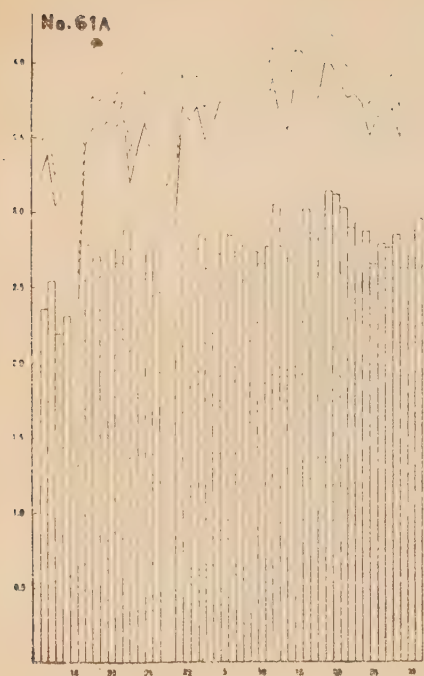


Fig. 41. Amount of leaves eaten by *Phraortes kumamotoensis*. No. 61, during the later larval and adult stadia. Abscissa represents time in date from June to September.

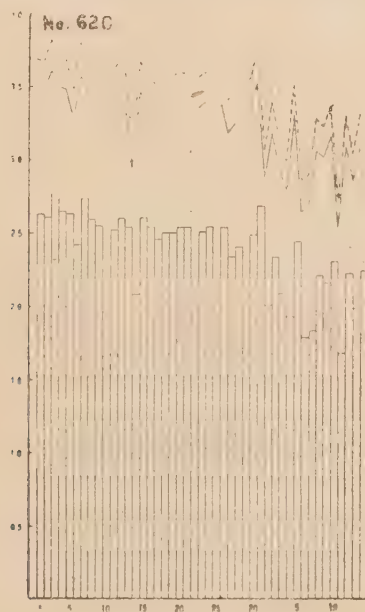
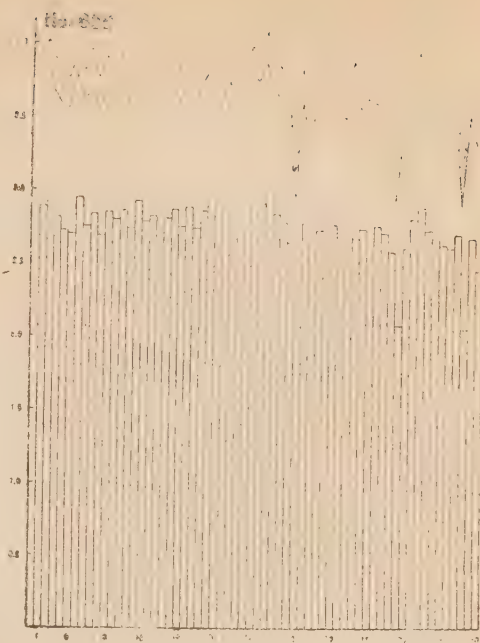
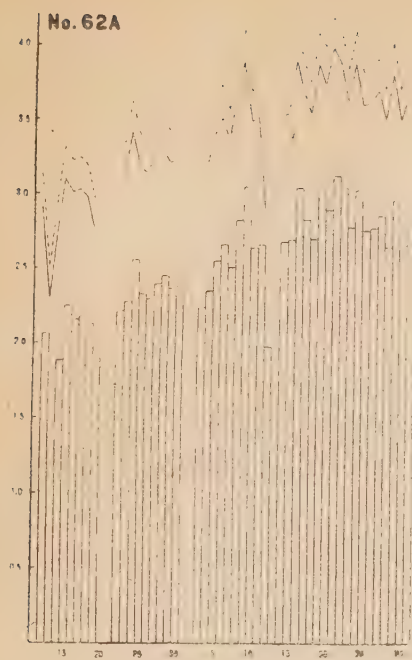


Fig. 42. Amount of leaves eaten by *Phraortes kumamotoensis*, No. 62, during the later larval and adult stadia. Abscissa represents time in date from June to November.

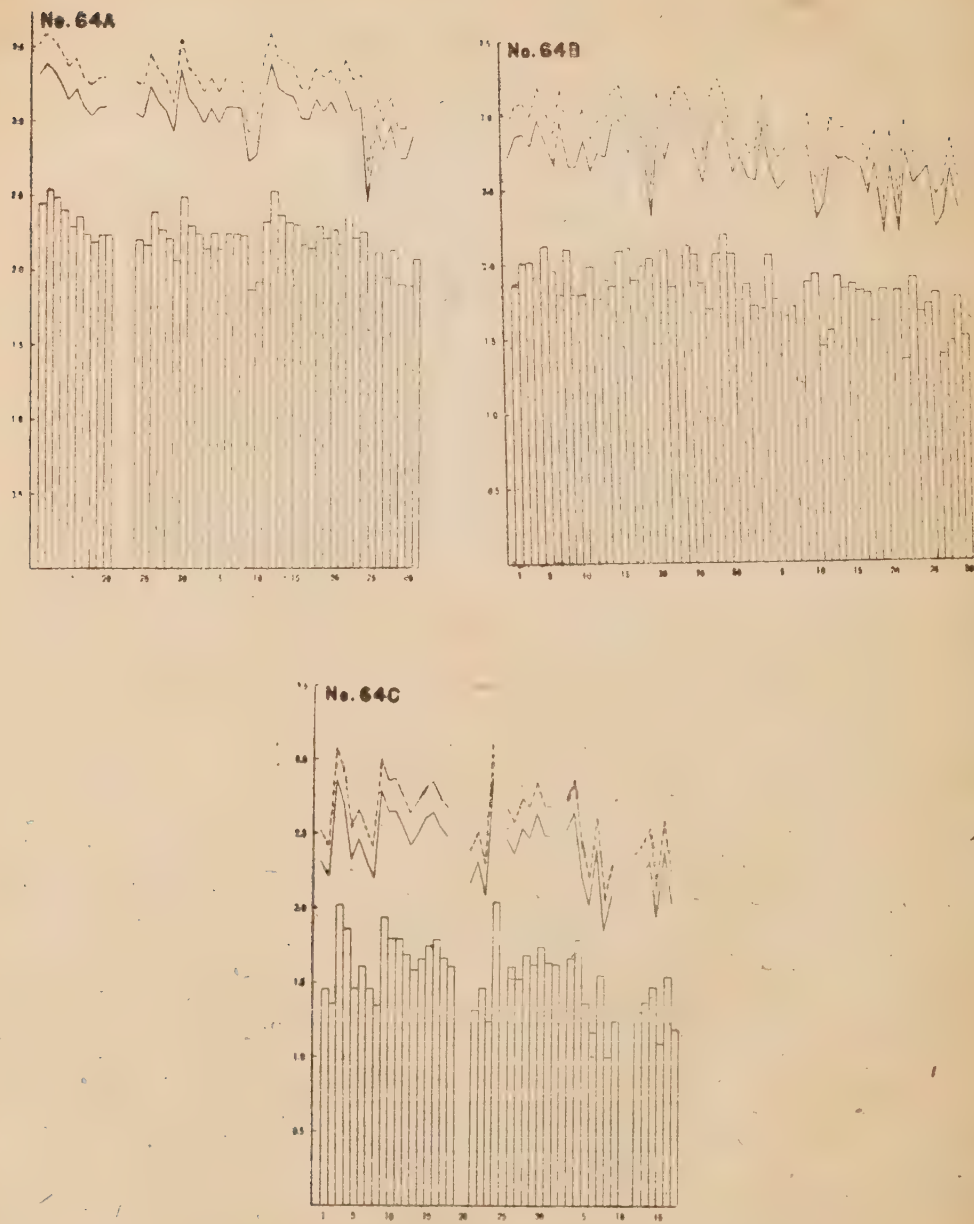


Fig. 43. Amount of leaves eaten by *Phraortes kumamotoensis*, No. 64, during the later larval and adult stadia. Abscissa represents time in date from June to November.

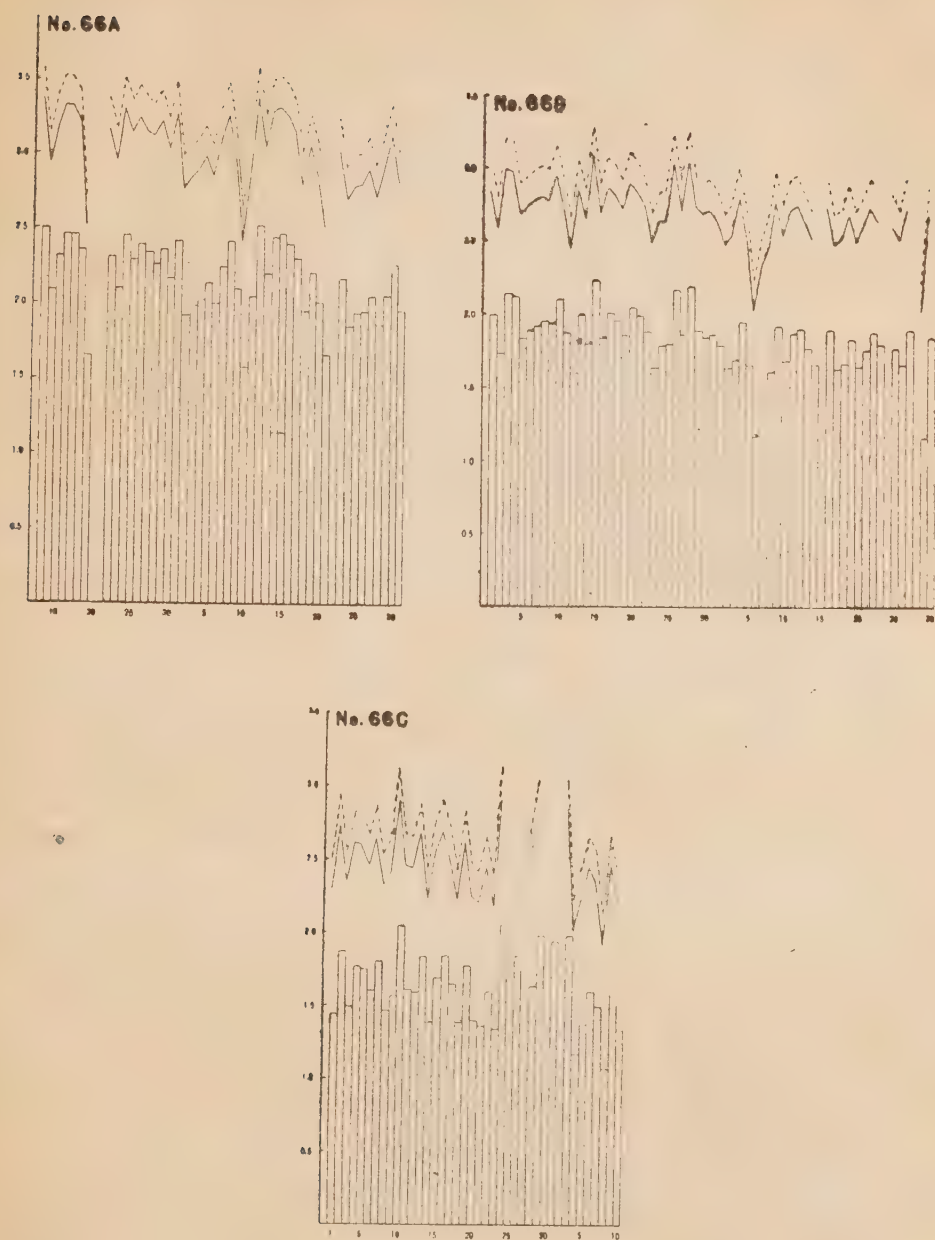


Fig. 44. Amount of leaves eaten by *Phraortes kumamotoensis*, No. 66, during the later larval and adult stadia. Abscissa represents time in date from June to November.

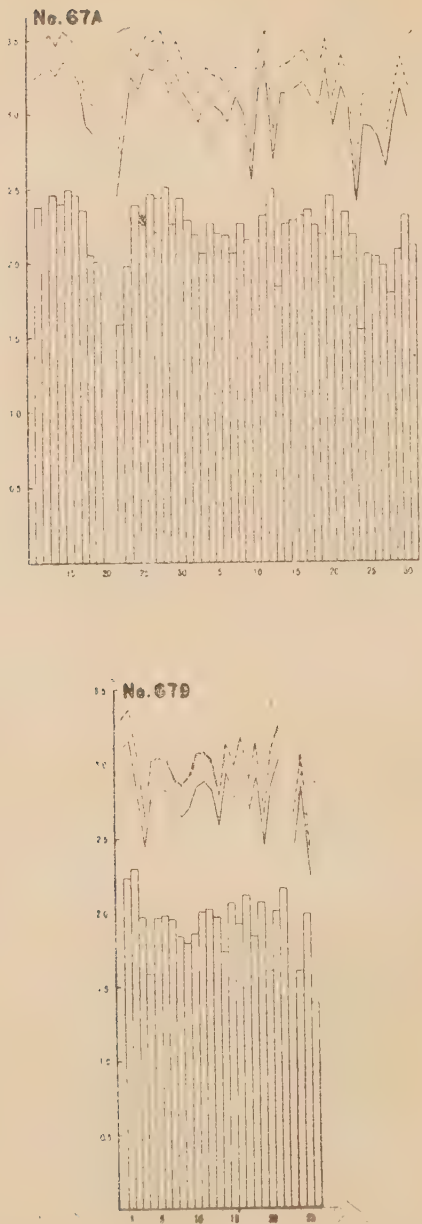


Fig. 45. Amount of leaves eaten by *Phraortes kumamotoensis*, No. 67, during the larval and adult stadia. Abscissa represents time in date from June to August.

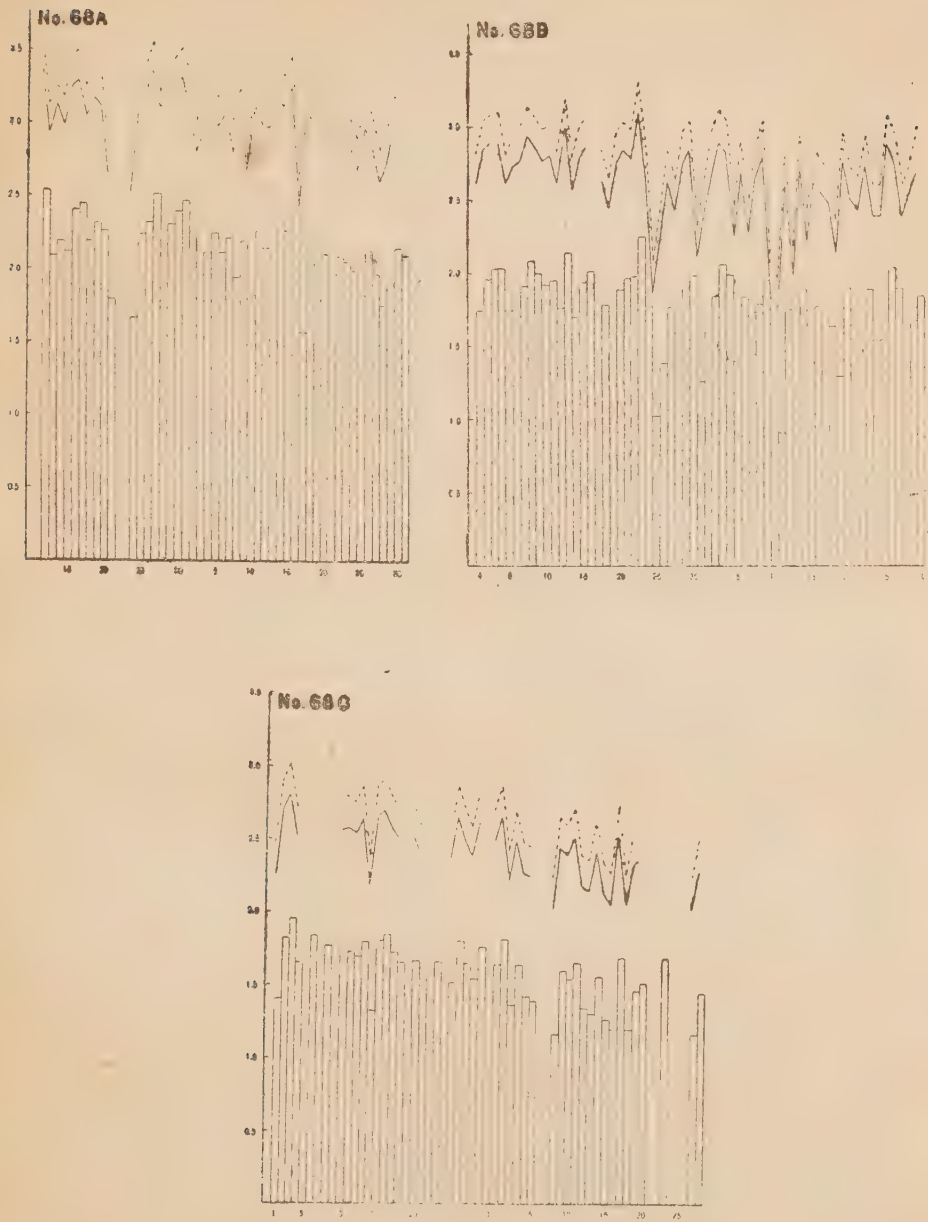


Fig. 46. Amount of leaves eaten by *Phraortes kumamotoensis*, No. 68, during the later larval and adult stadia. Abscissa represents time in date from June to November.

Table 145. Amount of leaves eaten by *Phraortes kumamotoensis* No. 60 in larval and adult stages

Date	V	O	W	Date	V	O	W
9. vi.	0.0	0	0	18. viii.	340.0	2415	3911
10. vi.	266.0	1889	3059	19. viii.	443.0	3145	5095
11. vi.	267.0	1896	3071	20. viii.	728.5	5172	8378
12. vi.	333.0	2364	3830	21. viii.	410.0	2911	4715
13. vi.	292.5	2077	3364	22. viii.	296.0	2102	3404
14. vi.	139.7	992	1607	23. viii.	666.0	4729	7659
15. vi.	329.4	2339	3788	24. viii.	606.3	4303	6969
16. vi.	335.2	2380	3855	25. viii.	256.0	1818	2944
17. vi.	299.6	2127	3445	26. viii.	548.0	3891	6302
18. vi.	128.5	912	1478	27. viii.	162.2	1152	1865
19. vi.	0.0	0	0	28. viii.	652.3	4631	7501
20. vi.	0.0	0	0	29. viii.	258.0	1832	2967
21. vi.	226.0	1605	2599	30. viii.	748.0	5311	8602
22. vi.	276.0	1960	3174	31. viii.	729.5	5179	8389
23. vi.	327.8	2324	2764	1. ix.	233.0	1654	2680
24. vi.	434.0	3081	4991	2. ix.	683.4	4852	7859
25. vi.	397.5	2822	4571	3. ix.	297.2	2110	3418
26. vi.	471.0	3344	5417	4. ix.	200.5	1424	2306
27. vi.	346.0	2457	3979	5. ix.	545.0	3870	6268
28. vi.	469.3	3332	5397	6. ix.	479.5	3404	5514
29. vi.	446.5	3170	5135	7. ix.	222.0	1576	2553
30. vi.	543.0	3855	6245	8. ix.	581.5	4129	6687
1. vii.	573.0	4068	6490	9. ix.	491.3	3488	5650
2. vii.	238.0	1690	2737	10. ix.	719.8	5111	8278
3. vii.	0.0	0	0	11. ix.	328.9	2335	3782
4. vii.	0.0	0	0	12. ix.	674.4	4788	7756
5. vii.	221.0	1569	2542	13. ix.	381.3	2707	4385
6. vii.	521.0	3699	5992	14. ix.	612.1	4346	7039
7. vii.	837.0	5943	9726	15. ix.	272.8	1937	3137
8. vii.	919.3	6527	10572	16. ix.	508.1	3608	5843
9. vii.	1078.4	7657	12402	17. ix.	562.5	3994	6469
10. vii.	632.0	4487	7268	18. ix.	422.8	3002	4862
11. vii.	484.0	3436	5566	19. ix.	0.0	0	0
12. vii.	849.0	6028	9763	20. ix.	398.3	2828	4580
13. vii.	1180.2	8379	13572	21. ix.	530.4	3766	6100

14. vii.	974.0	6915	11201	22. ix.	441.5	3135	5077
15. vii.	786.6	5585	9046	23. ix.	0.0	0	0
16. vii.	568.0	4032	6532	24. ix.	592.4	4207	6812
17. vii.	731.4	5193	8411	25. ix.	247.5	1757	2846
18. vii.	789.5	5605	9079	26. ix.	0.0	0	0
19. vii.	1122.0	7966	12903	27. ix.	436.5	3099	5020
20. vii.	809.8	5750	9313	28. ix.	557.2	3956	6408
21. vii.	554.3	3936	6374	29. ix.	576.4	4092	6629
22. vii.	881.8	6261	10141	30. ix.	349.7	2483	4022
23. vii.	1065.4	7554	12252	1. x.	317.5	2254	3651
24. vii.	604.0	4288	6946	2. xi.	274.8	2661	4310
25. vii.	298.5	2119	3433	3. x.	684.0	4856	7866
26. vii.	582.5	4136	6699	4. x.	256.0	1813	2944
27. vii.	357.2	2536	4108	5. x.	363.7	2582	4182
28. vii.	601.0	4267	6912	6. x.	0.0	0	0
29. vii.	525.0	3728	6038	7. x.	425.0	3018	4888
30. vii.	470.3	3339	5408	8. x.	330.5	2347	3801
31. vii.	600.6	4264	6907	9. x.	334.0	2371	3841
1. viii.	662.4	4703	7618	10. x.	345.0	2450	3967
2. viii.	632.0	4487	7268	11. x.	61.0	433	702
3. viii.	458.5	3255	5273	12. x.	296.0	2102	3404
4. viii.	606.0	4303	6969	13. x.	0.0	0	0
5. viii.	423.0	3003	4864	14. x.	329.5	2339	3879
6. viii.	596.7	4237	6862	15. x.	64.8	460	745
7. viii.	584.0	4146	6716	16. x.	504.8	3584	5805
8. viii.	720.5	5116	8286	17. x.	0.0	0	0
9. viii.	852.0	6049	9798	18. x.	401.8	2854	4621
10. viii.	500.5	3554	5756	19. x.	119.0	845	1369
11. viii.	678.0	4814	7797	20. x.	0.0	0	0
12. viii.	696.0	4942	8004	21. x.	0.0	0	0
13. viii.	661.5	4697	7507	22. x.	271.4	1927	3121
14. viii.	553.7	3931	6368	23. x.	474.5	3369	5457
15. viii.	627.0	4452	7211	24. x.	0.0	0	0
16. viii.	491.2	3488	5649	25. x.	0.0	0	0
17. viii.	512.0	3635	5888				

Table 146. Amount of leaves eaten by *Phraortes kumamotoensis* No. 61 in larval and adult stages.

Date	V	O	W	Date	V	O	W
11. vi.	232.0	1647	2668	4. viii.	511.0	3928	5877
12. vi.	349.0	2477	4014	5. viii.	564.0	4004	6486
13. vi.	154.0	1093	1771	6. viii.	740.6	5258	8517
14. vi.	204.5	1452	2352	7. viii.	554.0	3933	6371
15. vi.	0.0	0	0	8. viii.	448.7	3183	5160
16. vi.	33.3	236	388	9. viii.	936.0	6446	10764
17. vi.	402.0	2854	4623	10. viii.	345.6	2454	3974
18. vi.	511.0	3628	5877	11. viii.	359.5	2552	4134
19. vi.	480.5	3412	5526	12. viii.	782.0	5552	8993
20. vi.	581.0	4125	6682	13. viii.	610.0	4331	7015
21. vi.	461.5	3277	5307	14. viii.	821.5	5833	9447
22. vi.	761.8	5409	8761	15. viii.	284.0	2016	3266
23. vi.	215.0	1527	2473	16. viii.	605.4	4298	6962
24. vi.	365.4	2594	4202	17. viii.	726.6	5159	8356
25. vi.	569.3	4042	6547	18. viii.	389.0	2762	4474
26. vi.	296.0	2102	3404	19. viii.	456.0	3238	5244
27. vi.	0.0	0	0	20. viii.	585.0	4154	6728
28. vi.	0.0	0	0	21. viii.	768.7	5458	8840
29. vi.	110.0	781	1265	22. viii.	547.5	3887	6296
30. vi.	724.6	5145	8333	23. viii.	731.0	5190	8407
1. vii.	569.5	4043	6549	24. viii.	452.0	3209	5198
2. vii.	709.0	5034	8154	25. viii.	454.8	3229	5230
3. vii.	419.2	2976	4821	26. viii.	236.0	1676	2714
4. vii.	531.0	3770	6107	27. viii.	690.0	4899	7935
5. vii.	767.7	5451	8829	28. viii.	484.4	3439	5571
6. vii.	702.5	4988	8079	29. viii.	550.6	3909	6332
7. vii.	588.8	4180	6771	30. viii.	246.0	1747	2829
8. vii.	612.7	4350	7046	31. viii.	784.0	5566	9016
9. vii.	535.2	3800	6155	1. ix.	511.5	3652	5882
10. vii.	445.0	3160	5118	2. ix.	460.0	3266	5290
11. vii.	591.0	4196	6797	3. ix.	456.0	3238	5244
12. vii.	1120.0	7952	12880	4. ix.	234.8	1667	2700
13. vii.	587.6	4172	6757	5. ix.	469.2	3331	5396
14. vii.	478.5	3397	5503	6. ix.	601.0	4267	6912
15. vii.	1024.0	7270	11776	7. ix.	69.5	493	799

16. vii.	1028.1	7300	11823	8. ix.	328.5	2332	3778
17. vii.	644.7	4577	4714	9. ix.	747.0	5304	8591
18. vii.	741.0	5261	8522	10. ix.	624.0	4558	7383
19. vii.	1360.4	9659	15645	11. ix.	400.8	2846	4609
20. vii.	1307.5	9283	15036	12. ix.	221.5	1573	2547
21. vii.	1046.0	7427	12029	13. ix.	501.0	3557	5762
22. vii.	792.0	5623	9108	14. ix.	423.3	3005	4868
23. vii.	842.8	5984	9692	15. ix.	432.7	3072	4976
24. vii.	747.0	5304	8591	16. ix.	164.0	1164	1886
25. vii.	444.7	3157	5114	17. ix.	388.8	2760	4471
26. vii.	605.3	4298	6961	18. ix.	469.0	3330	5394
27. vii.	577.0	4097	6636	19. ix.	587.0	4168	6751
28. vii.	700.5	4974	8056	20. ix.	510.0	3621	5865
29. vii.	422.0	2996	4853	21. ix.	523.4	3716	6019
30. vii.	654.7	4648	7529	22. ix.	205.5	1459	2363
31. vii.	891.6	6330	10253	23. ix.	406.0	2883	4669
1. viii.	869.0	6170	9994	24. ix.	159.2	1130	1831
2. viii.	561.0	3983	6452	25. ix.	76.0	540	874
3. viii.	741.4	5264	8526	26. ix.	215.0	1527	2473

Table 147. Amount of leaves eaten by *Phraortes kumamotoensis* No. 62 in larval and adult stages.

Date	V	O	W	Date	V	O	W
12. vi.	115.0	817	1323	29. viii.	580.0	4118	6670
13. vi.	28.4	202	327	30. viii.	836.0	5936	9614
14. vi.	77.0	547	886	31. viii.	825.8	5863	9496
15. vi.	178.2	1265	2049	1. ix.	1054.6	7488	12127
16. vi.	146.0	1037	1679	2. ix.	697.0	4949	8016
17. vi.	149.5	1061	1719	3. ix.	609.2	4325	7006
18. vi.	132.5	941	1524	4. ix.	447.4	3177	5145
19. vi.	80.0	568	920	5. ix.	119.0	845	1369
20. vi.	0.0	0	0	6. ix.	602.0	4274	6923
21. vi.	0.0	0	0	7. ix.	298.0	2116	3427
22. vi.	161.4	1146	1856	8. ix.	544.5	3866	6262
23. vi.	189.0	1342	2174	9. ix.	693.5	4924	7975
24. vi.	359.6	2553	4135	10. ix.	601.6	4271	6918
25. vi.	211.5	1502	2432	11. ix.	489.3	3474	5627

26.	vi.	195.0	1385	2243	12.	ix.	445.0	3160	5118
27.	vi.	248.8	1766	2861	12.	ix.	674.0	4785	7751
28.	vi.	278.8	1979	3206	14.	ix.	547.1	3881	6292
29.	vi.	231.0	1640	2657	15.	ix.	365.2	2593	4200
30.	vi.	233.0	1654	2680	16.	ix.	576.0	4090	6624
1.	vii.	0.0	0	0	17.	ix.	529.4	3759	6088
2.	vii.	0.0	0	0	18.	ix.	382.3	2714	4396
3.	vii.	170.6	1211	1962	19.	ix.	120.5	856	1386
4.	vii.	221.5	1573	2547	20.	ix.	405.7	2880	4666
5.	vii.	350.6	2489	4032	21.	ix.	641.0	4551	7372
6.	vii.	462.0	3280	5313	22.	ix.	788.2	5596	9064
7.	vii.	316.0	2241	3634	23.	ix.	537.4	3816	6180
8.	vii.	652.4	4632	7503	24.	ix.	482.1	3423	5544
9.	vii.	1108.2	7888	12744	25.	ix.	434.0	3081	4991
10.	vii.	424.0	3010	4876	26.	ix.	415.6	2951	4779
11.	vii.	452.8	3215	5207	27.	ix.	511.0	3628	5877
12.	vii.	93.3	662	1073	28.	ix.	116.0	824	1334
13.	vii.	0.0	0	0	29.	ix.	473.8	3364	5449
14.	vii.	471.2	3346	5419	30.	ix.	296.0	2102	3404
15.	vii.	487.0	3458	5600	1.	x.	431.5	3064	4962
16.	vii.	1098.7	7801	12635	2.	x.	410.4	2914	4720
17.	vii.	670.0	4757	7705	3.	x.	580.6	4122	6677
18.	vii.	488.0	3465	5612	4.	x.	450.3	3197	5178
19.	vii.	1039.5	7380	11951	5.	x.	429.7	3051	4942
20.	vii.	759.5	5392	8734	6.	x.	261.2	1855	3004
21.	vii.	1325.6	9412	15244	7.	x.	554.0	3933	6371
22.	vii.	1081.4	7678	12436	8.	x.	391.4	2779	4501
23.	vii.	591.0	4196	6797	9.	x.	357.0	2535	4106
24.	vii.	1054.7	7488	12129	10.	x.	0.0	0	0
25.	vii.	558.8	3967	6426	11.	x.	331.0	2350	3807
26.	vii.	575.8	4088	6622	12.	x.	397.0	2819	4566
27.	vii.	702.0	4984	8073	13.	x.	344.5	2446	3962
28.	vii.	438.0	3110	5037	14.	x.	121.5	863	1397
29.	vii.	895.0	6354	10292	15.	x.	405.5	2879	4663
30.	vii.	442.4	3141	5088	16.	x.	346.4	2459	3984
31.	vii.	638.0	4530	7337	17.	x.	289.0	2052	3324
1.	viii.	770.5	5471	8861	18.	x.	314.3	2232	3614
2.	viii.	928.2	6590	10664	19.	x.	316.2	2245	3636
3.	viii.	644.0	4572	7406	20.	x.	348.0	2471	4002

4. viii.	532.0	357.1	6118	21. x.	349.0	2478	4014
5. viii.	502.7	366.9	5781	22. x.	0.0	0	0
6. viii.	877.3	622.9	10089	23. x.	321.6	2283	3698
7. viii.	565.0	411.2	6497	24. x.	350.7	2490	4033
8. viii.	676.0	480.0	7774	25. x.	0.0	0	0
9. viii.	500.0	355.0	5750	26. x.	350.0	2485	4025
10. viii.	700.4	497.3	8055	27. x.	217.8	1546	2505
11. viii.	624.3	443.3	7179	28. x.	257.2	1826	2958
12. viii.	720.0	511.2	8280	29. x.	0.0	0	0
13. viii.	551.2	391.1	6339	30. x.	312.0	2215	3588
14. viii.	834.0	592.1	9591	31. x.	474.4	3368	5456
15. viii.	605.5	429.9	6963	1. xi.	103.0	731	1186
16. viii.	665.0	472.2	7648	2. xi.	220.3	1564	2533
17. viii.	458.3	328.1	5270	3. xi.	123.9	880	1425
18. viii.	642.0	455.8	7383	4. xi.	85.6	608	984
19. viii.	728.2	517.0	8374	5. xi.	286.0	2031	3289
20. viii.	568.0	403.3	6533	6. xi.	63.0	447	725
21. viii.	761.5	540.7	8757	7. xi.	69.4	492	798
22. viii.	546.0	387.7	6279	8. xi.	165.0	1172	1898
23. viii.	732.0	519.7	8418	9. xi.	149.0	1058	1714
24. viii.	906.0	643.3	10419	10. xi.	204.0	1448	2346
25. viii.	0.0	0	0	11. xi.	48.6	345	559
26. viii.	766.4	544.1	8814	12. xi.	172.0	1221	1978
27. viii.	459.7	326.4	5287	13. xi.	98.5	709	1133
28. viii.	489.3	347.4	5629	14. xi.	179.4	1274	2063

Table 148. Amount of leaves eaten by *Phraortes kumamotoensis* No. 64 in larval and adult stages.

Date	V	O	W	Date	V	O	W
11. vi.	286.0	2031	3288	30. viii.	116.1	826	1339
12. vi.	345.2	2451	3970	31. viii.	57.0	405	656
13. vi.	308.5	2190	3518	1. ix.	72.5	515	834
14. vi.	255.3	1813	2935	2. ix.	51.3	364	590
15. vi.	198.0	1406	2277	3. ix.	50.0	355	575
16. vi.	231.0	1640	2657	4. ix.	113.1	805	1303
17. vi.	171.3	1216	1970	5. ix.	56.6	402	651
18. vi.	152.0	1079	1748	6. ix.	13.7	310	503

19. vi.	170.5	1211	1961	7. ix.	50.2	356	577
20. vi.	173.0	1228	1990	8. ix.	0.0	0	0
21. vi.	0.0	0	0	9. ix.	75.5	536	868
22. vi.	0.0	0	0	10. ix.	85.0	604	978
23. vi.	0.0	0	0	11. ix.	27.0	192	310
24. vi.	159.4	1132	1833	12. ix.	35.0	249	403
25. vi.	148.0	1051	1702	13. ix.	79.5	563	914
26. vi.	243.2	1727	2797	14. ix.	67.4	479	775
27. vi.	189.5	1345	2179	15. ix.	70.0	497	805
28. vi.	162.0	1150	1863	16. ix.	64.5	458	742
29. vi.	116.0	814	1334	17. ix.	62.0	433	702
30. vi.	310.5	2205	3571	18. ix.	40.0	284	460
1. vii.	199.2	1414	2291	19. ix.	65.5	465	753
2. vii.	172.0	1221	1978	20. ix.	22.2	158	255
3. vii.	137.0	973	1576	21. xi.	64.0	454	736
4. vii.	174.4	1238	1906	22. ix.	22.0	156	253
5. vii.	137.0	973	1576	23. ix.	76.4	542	879
6. vii.	168.5	1196	1938	24. ix.	46.0	327	529
7. vii.	172.0	1221	1978	25. ix.	51.3	364	590
8. vii.	166.5	1182	1915	26. ix.	61.0	433	702
9. vii.	74.0	525	851	27. ix.	23.5	167	270
10. vii.	82.6	586	950	28. ix.	29.0	206	334
11. vii.	212.0	1505	2438	29. ix.	56.5	401	650
12. vii.	336.5	2389	3870	30. ix.	31.0	220	357
13. vii.	232.0	1647	2668	1. x.	29.0	206	334
14. vii.	213.4	1515	2454	2. x.	23.0	163	265
15. vii.	200.0	1420	2300	3. x.	105.0	746	1208
16. vii.	146.5	1040	1685	4. x.	74.0	525	851
17. vii.	141.0	1001	1622	5. x.	29.5	209	339
18. vii.	194.6	1382	2238	6. x.	41.0	291	472
19. vii.	163.0	1157	1875	7. x.	29.0	206	334
20. vii.	189.0	1342	2174	8. x.	22.5	160	259
21. vii.	150.6	1069	1732	9. x.	88.6	629	1019
22. vii.	225.4	1600	2592	10. x.	64.0	454	736
23. vii.	165.2	1173	1900	11. x.	63.7	452	733
24. vii.	174.0	1235	2001	12. x.	50.0	355	575
25. vii.	39.0	277	449	13. x.	38.6	274	444
26. vii.	131.5	934	1512	14. x.	46.5	330	535
27. vii.	86.0	611	989	15. x.	57.4	408	660

28. vii.	134.0	951	1441	16. x.	62.0	440	713
29. vii.	79.0	561	908	17. x.	47.8	339	550
30. vii.	77.5	550	891	18. x.	42.5	302	489
31. vii.	113.6	807	1306	19. x.	0.0	0	0
1. viii.	73.0	518	840	20. x.	0.0	0	0
2. viii.	102.5	728	1179	21. x.	21.0	149	242
3. viii.	104.0	738	1196	22. x.	29.0	206	334
4. viii.	85.0	604	978	23. x.	17.5	124	202
5. viii.	133.5	918	1535	24. x.	111.4	791	1281
6. viii.	93.0	660	1070	25. x.	0.0	0	0
7. viii.	63.5	451	730	26. x.	41.0	291	472
8. viii.	126.0	895	1449	27. x.	33.5	238	385
9. viii.	64.0	454	736	28. x.	48.0	341	552
10. viii.	63.4	450	729	29. x.	42.0	298	483
11. viii.	96.0	671	1104	30. x.	62.0	440	713
12. viii.	59.0	419	679	31. x.	43.5	309	500
13. viii.	79.0	561	909	1. xi.	42.5	302	489
14. viii.	72.5	515	831	2. xi.	0.0	0	0
15. viii.	122.0	896	1403	3. xi.	47.4	337	545
16. viii.	131.0	930	1507	4. xi.	63.0	447	725
17. viii.	78.7	559	945	5. xi.	23.0	163	265
18. viii.	96.0	682	1104	6. xi.	14.5	103	167
19. viii.	100.8	716	1159	7. xi.	35.6	253	409
20. viii.	29.0	206	334	8. xi.	10.0	71	115
21. viii.	123.6	878	1421	9. xi.	17.6	125	202
22. viii.	70.0	497	805	10. xi.	0.0	0	0
23. viii.	113.5	806	1305	11. xi.	0.0	0	0
24. viii.	132.4	940	1523	12. xi.	20.0	142	230
25. viii.	115.0	817	1323	13. xi.	23.5	167	270
26. viii.	74.0	525	851	14. xi.	29.6	210	340
27. viii.	49.5	351	569	15. xi.	12.4	88	143
28. viii.	117.0	831	1345	16. xi.	34.0	241	391
29. viii.	152.0	1079	1748	17. xi.	15.4	109	177

Table 149. Amount of leaves eaten by *Phraortes kumamotoensis* No. 66 in larval and adult stages.

Date	V	O	W	Date	V	O	W
13. vi.	323.0	2293	3715	27. viii.	73.5	522	845
14. vi.	122.5	870	1409	28. viii.	157.0	1115	1806

15. vi.	210.4	1494	2420	29. viii.	78.0	554	897
16. vi.	290.0	2059	3335	30. viii.	70.5	501	811
17. vi.	288.6	2049	3319	31. viii.	72.6	515	835
18. vi.	228.5	1622	2628	1. ix.	62.4	443	718
19. vi.	45.7	324	526	2. ix.	43.0	305	495
20. vi.	0.0	0	0	3. ix.	50.1	356	576
21. vi.	0.0	0	0	4. ix.	90.0	639	1035
22. vi.	206.0	1463	2369	5. ix.	46.5	330	535
23. vi.	126.5	898	1455	6. ix.	15.0	107	173
24. vi.	287.0	2038	3301	7. ix.	59.1	209	338
25. vi.	194.5	1381	2237	8. ix.	41.0	291	472
26. vi.	247.3	1756	2844	9. ix.	84.3	599	969
27. vi.	214.5	1423	2467	10. ix.	50.0	355	575
28. vi.	185.6	1318	2134	11. ix.	74.6	530	858
29. vi.	231.5	1644	2662	12. ix.	80.3	570	923
30. vi.	151.0	1072	1737	13. ix.	60.0	426	690
1. vii.	265.0	1882	3048	14. ix.	46.5	330	535
2. vii.	83.4	592	959	15. ix.	0.0	0	0
3. vii.	97.6	693	1122	16. ix.	80.5	572	926
4. vii.	107.0	770	1231	17. xi.	42.8	304	492
5. vii.	135.5	962	1558	18. ix.	47.5	337	546
6. vii.	100.8	716	1159	19. ix.	69.0	490	794
7. vii.	175.0	1243	2013	20. ix.	45.7	324	526
8. vii.	260.0	1846	2990	21. ix.	58.0	412	668
9. vii.	124.3	883	1429	22. ix.	76.0	540	874
10. vii.	37.6	267	432	23. ix.	63.5	451	730
11. vii.	110.2	782	1267	24. ix.	0.0	0	0
12. vii.	334.5	2375	3847	25. ix.	60.0	426	690
13. vii.	160.0	1136	1840	26. ix.	46.0	327	529
14. vii.	277.2	1968	3188	27. ix.	80.5	572	926
15. vii.	294.0	2087	3381	28. ix.	0.0	0	0
16. vii.	250.6	1779	2882	29. ix.	14.5	103	167
17. vii.	202.8	1440	2332	30. ix.	71.0	504	817
18. vii.	90.6	643	1042	1. x.	27.8	197	330
19. vii.	162.4	1158	1868	2. x.	75.5	536	868
20. vii.	103.0	731	1185	3. x.	31.6	224	363
21. vii.	46.5	330	535	4. x.	58.0	412	668
22. vii.	0.0	0	0	5. x.	56.7	403	662
23. vii.	148.9	1057	1712	6. x.	49.0	284	460

24. vii.	71.0	504	817	7. x	122.6	452	731
25. vii.	87.5	621	1006	8. x.	30.0	213	345
26. vii.	95.0	639	1035	9. x.	36.7	261	432
27. vii.	112.6	799	1295	10. x	112.4	798	1293
28. vii.	75.5	535	868	11. x.	41.0	261	472
29. vii.	116.0	823	1334	12. x.	39.5	280	454
30. vii.	188.0	1335	2162	13. x.	68.5	486	788
31. vii.	93.0	600	1070	14. x.	24.0	170	276
1. viii.	100.8	716	1159	15. x.	50.0	355	575
2. viii.	54.9	330	631	16. x.	70.0	497	805
3. viii.	141.0	1001	1622	17. x.	15.0	320	518
4. viii.	131.5	934	1512	18. x.	24.0	170	276
5. viii.	68.7	488	790	19. x	60.0	426	690
6. viii.	76.0	540	874	20. x.	25.5	181	293
7. viii.	83.8	595	961	21. x	23.0	163	265
8. viii.	90.0	639	1035	22. x.	30.0	234	460
9. viii.	86.5	614	995	23. x.	22.0	156	253
10. viii.	126.2	896	1451	24. x.	114.5	813	1317
11. viii.	75.1	533	864	25. x.	0.0	0	0
12. viii.	40.4	287	465	26. x	70.0	497	805
13. viii.	101.0	717	1162	27. x	0.0	0	0
14. viii.	63.2	499	727	28. x.	43.0	305	495
15. viii.	173.0	1228	1990	29. x	96.5	685	1110
16. viii.	69.0	490	794	30. x.	0.0	0	0
17. viii.	104.5	742	1202	31. x.	88.4	628	1017
18. viii.	92.4	656	1063	1. xi.	0.0	0	0
19. viii.	74.0	525	851	2. xi.	97.6	693	1122
20. viii.	113.5	806	1305	3. xi.	15.0	107	173
21. viii.	98.2	697	1129	4. xi	23.7	168	273
22. viii.	76.0	540	874	5. xi.	40.5	288	466
23. viii.	43.7	310	503	6. xi	32.0	227	368
24. viii.	60.8	432	699	7. xi.	12.0	85	138
25. viii.	62.0	440	713	8. xi	40.7	289	468
26. viii.	150.6	1069	1732	9. xi.	22.0	156	253

Table 150. Amount of leaves eaten by *Phraortes kumamotoensis* No. 67 on larval and adult stages.

Date	V	O	W	Date	V	O	W
11. vi.	242.0	1718	2783	20. vii.	282.0	2002	3243
12. vi.	259.5	1842	2984	21. vii.	112.0	795	1288
13. vi.	300.0	2130	3450	22. vii.	223.4	1586	2569
14. vi.	254.6	1807	2928	23. vii.	156.0	1108	1794
15. vi.	317.4	2254	3650	24. vii.	36.0	256	414
16. vi.	289.5	2055	3329	25. vii.	119.0	844	1368
17. vi.	232.0	1647	2668	26. vii.	112.3	797	1281
18. vi.	115.0	817	1323	27. vii.	96.0	682	1104
19. vi.	104.5	741	1201	28. vii.	62.8	446	722
20. vi.	0.0	0	0	29. vii.	123.0	873	1414
21. vi.	0.0	0	0	30. vii.	210.0	1491	2415
22. vi.	39.4	280	453	31. vii.	132.4	940	1523
23. vi.	96.0	693	1104	1. viii.	171.0	1214	1967
24. vi.	248.5	1764	2858	2. viii.	200.0	1420	2300
25. vi.	212.0	1505	2438	3. viii.	95.2	671	1095
26. vi.	299.0	2133	3439	4. viii.	38.2	271	439
27. vi.	271.3	1926	3120	5. viii.	92.0	653	1058
28. vi.	330.0	2343	3795	6. viii.	94.0	667	1081
29. vi.	189.7	1347	2182	7. viii.	91.5	650	1052
30. vi.	278.2	1975	3198	8. viii.	68.4	486	787
1. vii.	196.0	1392	2254	9. viii.	63.0	447	724
2. vii.	157.0	1114	1806	10. viii.	71.5	508	822
3. vii.	120.0	852	1385	11. viii.	100.6	704	1157
4. vii.	183.5	1303	2110	12. viii.	106.0	752	1219
5. vii.	162.5	1154	1869	13. viii.	95.2	676	1095
6. vii.	152.0	1079	1748	14. viii.	54.0	383	621
7. vii.	120.0	852	1385	15. viii.	120.0	852	1380
8. vii.	185.0	1314	2128	16. viii.	84.0	596	966
9. vii.	142.2	1010	1635	17. viii.	133.5	948	1535
10. vii.	48.0	341	552	18. viii.	68.0	483	782
11. vii.	211.5	1502	2432	19. viii.	118.0	838	1357
12. vii.	323.0	2293	3715	20. viii.	40.5	288	466
13. vii.	70.0	497	805	21. viii.	104.0	738	1196
14. vii.	188.0	1335	2162	22. viii.	146.0	1036	1779
15. vii.	193.3	1372	2213	23. viii.	0.0	0	0
16. vii.	210.0	1491	2415	24. viii.	40.0	284	460
17. vii.	233.1	1655	2680	25. viii.	98.5	699	1133
18. vii.	185.0	1313	2127	26. viii.	24.2	172	278
19. vii.	161.0	1143	1852				

Table 151. Amount of leaves eaten by *Phraortes kumamotoensis* No. 68 in larval and adult stages.

Date	V	O	W	Date	V	O	W
11. vi.	0.0	0	0	5. ix.	25.4	180	292
12. vi.	346.1	2457	3980	6. ix.	68.3	485	785
13. vi.	119.2	846	1371	7. ix.	28.0	199	322
14. vi.	156.3	1316	1797	8. ix.	63.0	447	723
15. vi.	132.0	937	1518	9. ix.	88.5	628	1118
16. vi.	251.0	1782	2887	10. ix.	10.0	71	115
17. vi.	275.4	1955	3167	11. ix.	8.2	58	94
18. vi.	155.0	1100	1783	12. ix.	56.0	398	644
19. vi.	210.2	1492	2417	13. ix.	13.4	95	154
20. vi.	180.0	1278	2070	14. ix.	75.5	536	868
21. vi.	61.0	433	702	15. ix.	24.0	170	276
22. vi.	0.0	0	0	16. ix.	60.0	426	690
23. vi.	0.0	0	0	17. ix.	50.5	359	581
24. vi.	46.5	330	535	18. ix.	42.7	303	491
25. vi.	170.3	1209	1958	19. ix.	20.0	142	230
26. vi.	211.0	1498	2427	20. ix.	81.0	575	931
27. vi.	325.3	2340	3741	21. ix.	45.0	319	518
28. vi.	182.0	1292	2093	22. ix.	39.5	280	454
29. vi.	200.0	1420	2300	23. ix.	76.0	540	874
30. vi.	244.0	1732	2706	24. ix.	34.6	246	398
1. vii.	288.5	2049	3318	25. ix.	35.0	249	403
2. vii.	179.0	1271	2059	26. ix.	107.5	763	1236
3. vii.	90.0	639	1035	27. ix.	76.0	540	874
4. vii.	127.7	907	1469	28. ix.	35.0	249	403
5. vii.	173.5	1232	1995	29. ix.	47.7	339	549
6. vii.	130.0	923	1495	30. ix.	70.0	497	1005
7. vii.	164.0	1164	1886	1. x.	25.5	181	293
3. vii.	87.4	621	1005	2. x.	67.1	479	775
9. vii.	153.0	1086	1759	3. x.	90.0	639	1035
10. vii.	66.0	469	759	4. x.	45.7	324	525
11. vii.	186.0	1320	2119	5. x.	0.0	0	0
12. vii.	139.7	992	1599	6. x.	68.5	486	787
13. vii.	131.6	934	1513	7. x.	0.0	0	0
14. vii.	215.0	1527	2473	8. x.	59.0	419	679
15. vii.	183.6	1304	2111	9. x.	0.0	0	0

16. vii.	253.0	1796	2909	10. x.	52.0	369	598
17. vii.	37.4	254	430	11. x.	53.2	378	612
18. vii.	160.0	1136	1349	12. x.	49.5	351	569
19. vii.	148.0	1451	1702	13. x.	62.4	442	728
20. vii.	126.0	891	1459	14. x.	21.0	149	242
21. vii.	93.5	664	1075	15. x.	64.0	454	736
22. vii.	119.8	852	1378	16. x.	70.0	497	805
23. vii.	112.0	795	1288	17. x.	53.0	376	610
24. vii.	98.0	696	1127	18. x.	45.0	320	518
25. vii.	65.5	465	753	19. x.	0.0	0	0
26. vii.	131.0	930	1507	20. x.	46.0	327	529
27. vii.	92.6	657	1065	21. x.	34.0	241	391
28. vii.	56.5	401	650	22. x.	0.0	0	0
29. vii.	78.0	554	897	23. x.	46.5	330	535
30. vii.	135.5	962	1558	24. x.	0.0	0	0
31. vii.	121.0	859	1392	25. x.	33.0	234	380
1. viii.	57.0	405	656	26. x.	64.5	458	742
2. viii.	94.5	671	1087	27. x.	45.3	321	521
3. viii.	108.0	767	1242	28. x.	34.0	241	391
4. viii.	109.8	780	1263	29. x.	59.5	422	681
5. viii.	56.8	403	653	30. x.	0.0	0	0
6. viii.	75.0	533	863	31. x.	0.0	0	0
7. viii.	83.0	589	955	1. xi.	44.0	312	506
8. viii.	119.5	848	1374	2. xi.	65.5	465	753
9. viii.	100.0	710	1150	3. xi.	23.0	163	265
10. viii.	84.0	596	966	4. xi.	44.0	312	506
11. viii.	89.6	636	1030	5. xi.	26.5	188	305
12. viii.	58.0	412	667	6. xi.	25.0	178	288
13. viii.	137.5	976	1581	7. xi.	0.0	0	0
14. viii.	51.0	362	587	8. xi.	0.0	0	0
15. viii.	87.0	618	1001	9. xi.	15.0	107	173
16. viii.	104.0	738	1196	10. xi.	40.5	288	466
17. viii.	0.0	0	0	11. xi.	35.0	249	403
18. viii.	61.5	437	707	12. xi.	46.0	327	529
19. viii.	39.0	277	448	13. xi.	22.0	156	253
20. viii.	79.0	561	909	14. xi.	20.0	142	230
21. viii.	94.5	671	1087	15. xi.	37.5	266	431
22. viii.	86.3	613	882	16. xi.	19.0	135	219
23. viii.	178.0	1264	2047	17. xi.	16.0	114	184

24. viii.	60.0	426	690	18. xi.	50.0	355	575
25. viii.	10.5	75	121	19. xi.	16.0	114	184
26. viii.	25.0	178	288	20. xi.	30.0	213	345
27. viii.	59.2	420	681	21. xi.	32.6	231	375
28. viii.	37.7	268	434	22. xi.	0.0	0	0
29. viii.	80.0	568	920	23. xi.	0.0	0	0
30. viii.	95.2	676	1095	24. xi.	50.0	355	575
31. viii.	18.4	131	212	25. x..	0.0	0	0
1. ix.	41.0	291	472	26. xi.	0.0	0	0
2. ix.	70.0	497	1005	27. xi.	0.0	0	0
3. ix.	111.5	792	1282	28. xi.	15.0	107	173
4. ix.	96.0	682	1104	29. xi.	28.5	202	327

Observations

The data derived from the two series of experiments may be classified as in the following tables. In these tables the following new abbreviations are added.

Va : Average volume of the leaf in mm³ eaten per day by an insect.

Oa : (Organic matter contents in mg in Va) $\times 10^5$.

Wa : (Water contents in mg in Va) $\times 10^5$.

Table 152. Food consumption of the experimental insect No. 59, ♀.

Instar or division	ΣV	Va	ΣO	Oa	ΣW	Wa
Instar V	1686.1	210.7	11972	1496.5	19391	2423.7
VI	3752.6	312.7	26644	2223.0	43156	3596.3
Adult	45594.7	353.4	385793	2990.6	543649	4214.3
Preoviposition period	4616.8	512.9	32780	3643.3	53093	5899.2
Division I (20 days)		630.7		4477.8		7228.2
II (20 days)		415.3		2948.9		4776.5
III (20 days)		400.5		2861.3		4608.6
IV (20 days)		327.4		2325.0		3771.0
V (20 days)		203.3		1043.3		2393.4
VI (20 days)		146.1		860.7		1393.6
VII (8 days)		90.2		640.0		1037.1

Table 153. Food consumption of the experimental insect No. 60, ♀.

Instar or division	ΣV	Va	ΣO	Oa	ΣW	Wa
Instar V	2390.9	265.7	16976	1886.2	27497	3055.2
VI	4747.6	395.6	33708	2809.0	54499	4541.5
Adult	54442.2	481.7	286557	2358.9	625784	5537.9
Preoviposition period	7695.9	769.6	54640	5464.0	88604	8860.4
Division I (20 days)		655.0		4660.7		7538.0
II (20 days)		569.3		4042.5		6516.8
III (20 days)		470.8		3342.9		5414.5
IV (20 days)		379.1		2682.5		4364.5
V (23 days)		224.3		1624.0		2630.4

Table 154. Food consumption of the experimental insect No. 61, ♀.

Instar or division	ΣV	Va	ΣO	Oa	ΣW	Wa
Instar VI	4676.8	425.2	32936	2994.1	53790	4890.0
Adult	51337.6	570.4	369430	4104.7	585643	6507.1
Preoviposition period	5735.0	573.5	40718	4071.8	65954	6595.4
Division I (20 days)		780.9		5799.5		8980.6
II (20 days)		621.2		4402.0		7146.4
III (20 days)		505.4		3589.3		5561.9
IV (20 days)		372.6		2649.6		4295.4

Table 155. Food consumption of the experimental insect No. 62, ♀.

Instar or division	ΣV	Va	ΣO	Oa	ΣW	Wa
Instar V	2108.1	234.2	14967	1663.0	24244	2693.7
VI	4251.4	425.1	30234	3023.4	48893	4889.3
Adult	59887.8	482.9	425424	3430.8	683097	5508.8
Preoviposition period	5013.9	716.2	35599	5085.5	57659	8237.0
Division I (20 days)		714.9		5085.9		8221.1
II (20 days)		616.9		4380.0		6812.9
III (20 days)		566.8		4024.9		6519.2
IV (20 days)		436.5		3099.3		5020.0
V (20 days)		270.8		1922.9		3114.9
VI (17 days)		161.9		1150.7		1863.5

Table 156. Food consumption of the experimental insect No. 64, ♂.

Instar or division		ΣV	Va	ΣO	Oa	ΣW	Wa
Instar V		2290.8	229.1	16265	1626.5	26346	2634.6
Adult		12450.4	84.7	92374	628.5	143070	973.2
Division	I (20 days)		178.6		1274.7		2060.7
	II (20 days)		139.9		993.5		1604.4
	III (20 days)		89.5		835.0		1029.3
	IV (20 days)		77.6		550.9		892.4
	V (20 days)		49.8		353.1		575.9
	VI (20 days)		45.3		321.6		521.2
	VII (20 days)		34.7		241.9		391.9
	VIII (7 days)		19.3		136.7		221.5

Table 157. Food consumption of the experimental insect No. 66, ♂.

Instar or division		ΣV	Va	ΣO	Oa	ΣW	Wa
Instar V		1218.0	174.0	10711	1530.1	17352	2478.8
Adult		12310.6	87.3	87528	620.7	142920	11013.6
Division	I (20 days)		166.5		1180.9		1920.7
	II (20 days)		145.2		1030.8		1669.9
	III (20 days)		93.3		662.3		1072.8
	IV (20 days)		70.2		498.7		807.7
	V (20 days)		49.7		353.4		572.4
	VI (20 days)		51.3		363.9		590.9
	VII (21 days)		39.3		281.2		511.4

Table 158. Food consumption of the experimental insect No. 67, ♂.

Instar or division		ΣV	Va	ΣO	Oa	ΣW	Wa
Instar V		2114.5	234.9	15011	1667.8	24316	2701.7
Adult		9187.4	139.2	65234	988.3	104744	1587.0
Division	I (20 days)		182.1		1293.9		2044.5
	II (20 days)		161.4		1145.9		1855.2
	III (20 days)		95.2		675.3		1905.1
	IV (6 days)		68.7		488.1		807.6

Table 159. Food consumption of the experimental insect No. 68, ♂.

Instar or division	ΣV	V_a	ΣO	O_a	ΣW	W_a
Instar V	1886.2	188.6	13593	1359.3	21692	2169.2
Adult	11664.0	72.9	80589	500.9	130718	817.0
Division I (20 days)		164.8		1169.9		1878.5
II (20 days)		118.9		841.2		1367.4
III (20 days)		81.2		576.3		933.5
IV (20 days)		67.7		416.8		690.0
V (20 days)		50.7		360.3		593.6
VI (20 days)		44.0		312.6		506.9
VI (20 days)		34.9		209.9		325.7
VII (20 days)		20.9		148.3		240.1

In the experiments the duration of adult life was divided into several periods in order to investigate the change in nature of food consumption with the age. Each period consisted of 20 days except the last one and noted as the first division, second division, etc. In the case of the females the preoviposition period was excluded from such divisions, i.e. the date of the first oviposition was the start of the first division.

As is seen from the above tables it is clear that after the preoviposition period the amount of food eaten by each female has the tendency of decreasing towards the end of life. In the case of the males the same tendency was also clearly observed with the age after the emergence. This means that the longer is the life of the adult, the smaller is the average amount of food consumed per day. The percentage decrease of the food consumption with the age is summarized in the following table.

Table 160. Percentage decrease of the food consumption in the experimental insects with the age.

No.	Sex	Ma (Maximum)	Mi (Minimum)	Decrease or Ma-Mi(%)	Mean decrease per period or Ma-Mi
					t.n.p.
59	♀	100 (P ₁)	14.6 (P ₇)	85.4	12.2
60	♀	100 (Pr)	29.1 (P ₅)	70.9	14.1
61	♀	100 (P ₁)	48.1 (P ₄)	51.1	12.7
62	♀	100 (Pr)	22.7 (P ₈)	77.3	11.0
64	♂	100 (P ₁)	10.8 (P ₈)	89.2	11.1
66	♂	100 (P ₁)	23.6 (P ₇)	76.4	10.9
67	♂	100 (P ₁)	37.7 (P ₄)	62.3	15.5
68	♂	100 (P ₁)	12.6 (P ₈)	87.4	10.9

P₁ : Period I Pr : Preoviposition period

t.n.p. : Total number of the periods.

This table indicates that the amount of food consumed by the insects was decreasing with successive periods at the rate of 10.9—15.5 per cent with an average of 12.3 per cent. Further the foregoing tables may suggest some important conclusions as given in the following lines. The amount of food eaten per day by a female in her preoviposition period is almost equal to, or slightly larger than, the total amount of food consumed in the third stadium of her larval life, and distinctly smaller than the same in the fourth stadium. In the male sex the amount of food consumed per day in his first period of adult life is almost equal to the total amount of food eaten in the first stadium of his larval life and is about one-fourth or one-fifth the average amount of food consumed per day during the preoviposition period of the female. The value $\sum V$ in the preoviposition period is always larger than that in the last larval stage and approximately equal to the value of $\sum V_3$ and $\sum V_4$ taken together. This fact would indicate that an extremely large amount of food is necessary for the female during the preoviposition period in order to become mature and contrasts sharply with that obtained in the male. In the male the

value ΣV in the first period of adult life immediately after the last moult is always smaller than that of the preceding larval stage.

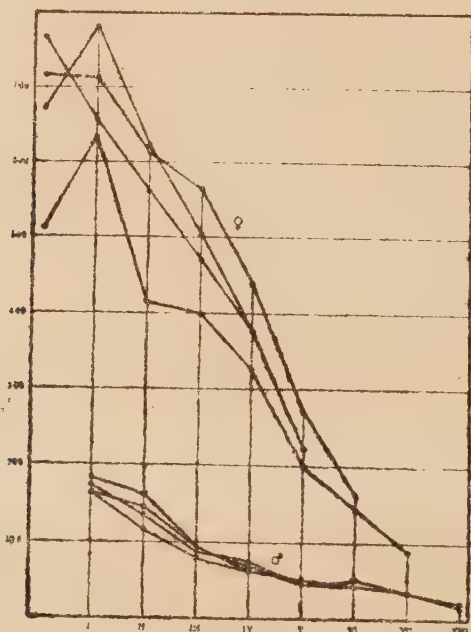


Fig. 47. Amount of leaves eaten by *Phraortes kumamotoensis* in the adult period.

D. Discussions

1. Historical

In his excellent review of insect nutrition and metabolism UVAROV (1928) called attention to the fact that a very few points on these problems have been touched and the results achieved were but a drop compared with the ocean of unknown phenomena. Although the voluminous bibliography concerning nutrition tells us upon what plants or in what media insects may be found, with the assumption that these plants and media constitute food of them, very little is said of what actually is used by the insect for

food or the amount of food consumed by the insect for the completion of the post-embryonic growth, the maintenance of its metabolism and for the reproduction. As is well known, the works made by UVAROV (1928), CHAPMAN (1931) and HODGE IV (1933) cover the literature on the problem in question. Among Orthoptera the contributions of ZABINSKI (1928, 1929) and HODGE IV (1933) are excellent. The first author used *Periplaneta orientalis* and *Blattella germanica* (Blattidae) in his experiment, feeding them with such artificial foodstuffs as ovalbumin, gelatin, glycocoll, starch, saccharose, agar-agar and mineral salt (MCCOLLUM and SIMONDS) and reported the following conclusions. During approximately the first one-third of the post-embryonic period they grew equally rapidly on synthetic as on normal diets. The entire development cycle of the blackbeetle (*Periplaneta orientalis*) could not be completed on a synthetic diet. Blackbeetle larvae put on synthetic diets half-way through the growth period could attain sexual maturity. The cockroach (*Blattella germanica*) was able to complete its entire development cycle on a synthetic diet, even when the only nitrogenous constituent was glycine. The symptoms of avitaminosis, which appeared after the above-stated time, were lack of mobility and the appearance of a matt surface of the chitin envelope; should sexual maturity be attained, small dimensions and infertility were characteristic symptoms. Ovalbumine might be replaced by biologically deficient proteins such as gelatin, or even by glycine, without in any way affecting the character of growth. By diminishing the percentage nitrogen content in diets the rate of growth was distinctly diminished, but at the same time the period of its duration was prolonged. Blackbeetles and cockroaches were exceptionally resistant to the absence of nitrogenous constituents in their food, being able to maintain their body-weight over periods of time equal in length to that of the entire normal post-embryonic cycle. Even after prolonged inhibition of growth, the administration of a normal diet allowed these animals to resume growth and attain sexual maturity, including the production of normal young. The rate of growth of insects which had been given normal food after long periods of inhibition of growth was independent of the actual age of the insect, and corresponded to that which the animal had possessed at the commencement of the period of inhibition. These insects did not

survive long if fed upon exclusively protein diets, in the absence of carbohydrates. The addition of small quantity of butter, yeast, or vitamin B extracts to synthetic and complete diets did not lead to any enhancement of growth. The second author, HODGE IV, used *Melanoplus differentialis* (Acrididae). The preferences of the insect have been determined in the field, under natural conditions, to be tall ragweed, smartweed, corn, the clovers, etc., and he fed them with such plants as plantain, dandelion, wheat, rye, barley, oats and lettuce, either alone or as a mixtures of these and other leafy plants and got the following results. The relatively poor development, irregular growth, susceptibility to pathological conditions, and higher mortality of the insect on such restricted diets as lettuce or oat leaves alone indicated that such criteria can be used as indications of dietary deficiency in further experiments with various insufficient diets. The better development of the insect, as shown by general vigor, longevity, and fertility, on the diets of wheat, barley, or rye leaves alone, showed that such single plant diets were clearly sufficient and satisfactory diets for this species. The growth curves for the insects on four different satisfactory diets were all of the type similar to one another. The variation of the weight of the insects was apparently not correlated with any particular diet,

In 1938, J. K. DE JONG published the study of influence of the quality of the food on the egg production in *Helopeltis theivora*, *Epilachna* sp., *Tinolius eburneigutta* and *Diacrisia strigatula*. The differences of food in quality were obtained by taking leaves of different age, by selecting plants of the same species and by technical methods. Thus the foods were classified into five kinds, and the experiments were carried out. From his experiments the following results were obtained. When the quantity of the carbohydrates in the food diminished the fertility of the insects: 1) decreased in *Epilachna*, *Tinolius*, *Toxoptera*, 2) increased in *Diacrisia*, 3) increased, at first, then decreased in *Helopeltis* and *Diacrisia*. In this connection experiments of K. H. HEIL (1936) on *Carausius morosus* called attention to the fact that it is necessary to use standard test plants for the different standard test insects to ascertain average values for all the customary test plants in feeding experiments or in testing the action of some insecticides.

The separate nutritional studies of hormones, vitamins, other

similar chemical compounds or yeasts for insects constitute a great and important field of biological science from the viewpoint of biochemistry and physiology. But there is no reason to say that the study of total amount of food consumed by insects or of the cumulative effect of the above mentioned nutritional components, is of less important. DAVIS and SATTERTHWAIT (1916) made an excellent work on the American army worm, *Cirphis unipuncta*, to determine the total amount of food eaten by healthy larvae under different feeding conditions. Their feeding experiments, where exact records of the amount of corn foliage eaten in each instar were kept, are especially interesting and instructive, for it will be noticed that more than 80 per cent of all the foliage eaten during the entire life of the larva was consumed during the last larval instar, which corroborates previous field observations to the effect that army worms rarely become evident and destructive until they are nearly fullgrown. In their experiments three types of rearing cages, tin boxes, glass test tubes and lantern globes, were used. The tin-box cages were kept indoors, and the other two kinds of apparatus were kept on a latticed porch and were therefore under more nearly normal outdoor conditions. The average lengths of the different stages for individuals in the lantern-globe cages and in glass vials were noticeably longer than for individuals reared in the tin boxes. The length of the first five larval instars did not vary greatly one from the other, although the amount of the foliage eaten in each of these instars was a gradual increase from nearly 0.03 of a square inch for the first instar to over 5 square inches for the fifth instar. The period for the six larval instar was noticeably longer than in any of the previous instars, being approximately two and one-half times as long; and the amount of foliage eaten in this instar was nearly seven times as much as in the fifth instar, and more than 80 per cent of all of the foliage eaten during the entire larval period. This remarkable voracity of the army worm during its last larval instar explains its sudden appearance in such enormous and destructive numbers only when it is nearly fullgrown. From these observations, they made the following interesting considerations. At the time of the outbreak of this army worm the corn is 2 feet in height. MONTGOMERY has shown that mature corn plants have a foliage area of 927.8 to 1912.9 square inches. Corn

plants 2 feet in height would have at the most not more than one-twelfth the foliage area of a mature plant; hence, it can be said with comparative assurance that a corn plant such as was found in Michigan during the 1914 outbreak would have no more than 100 square inches of foliage. Since one larva would eat 41.4 square inches, it would require five larvae to devour two corn plants. With 8890 corn plants to an acre ($2\frac{1}{2}$ plants to a hill and $3\frac{1}{2}$ feet each way), it would require 21473 worms to destroy an acre of corn 2 feet in height. Although seemingly a large number of worms, this number represents only the progeny of probably not more than 40 females.

Table 161. Corn foliage eaten by the army worm in different instars (unit in square inches) (after DAVIS and SATTERTHWAIT, 1916).

Instar	Foliage eaten	Rate of increase
I	0.0294	} 3.5
II	0.103	
III	0.338	} 3.3
IV	1.204	
V	5.364	} 3.6
VI	34.128	
		} 4.6
		} 6.3

In this connection TOWER (1916) published a very interesting comparative study of the amount of food eaten by parasitised and non-parasitised larvae of *Cirphus unipuncta*. From his experiments it will be seen that parasitised larvae ate approximately half as much as unparasitised larvae during the same periods, and it seems conclusive, even from these few records, that parasitism by *Apanteles militaris* is directly beneficial in the generation attacked. In the stick insect ROYH (1916) also made some experiments on the feeding habit. His conclusions were as follows. *Carausius morosus* is an irregular feeder, eating much on one day, little on the other day, and so on, but the amount of food is always more immediately after a moult than in later part of the same stadium. Their feeding generally takes place in the evening and in the

morning. The food consumption doubles with each successive stadium, the quantity consumed per mm length of the insect increases at the same time, thus; in the first stadium the consumption per mm length of the insect is 7 sq. mm, in the second 17.5 sq. mm, in the third 36, in the fourth 79.6, in the fifth 140, in the sixth 295, and after the sixth 597, and these figures are near to the series, 9, 18, 36, 72, 144, 288 and 576, respectively. For the two or three weeks immediately following the last ecdysis the insects eat enormously, but afterwards, generally speaking, they eat gradually less and less. There is a remarkable correspondence between the quantity of food consumed and the number of eggs produced. As with the egg-dropping, so too with the food consumption, the size of the insect appears to have nothing to do with the results, and a shorter insect may eat more than a longer one.

TITSCHACK's experiments on the growth and the food consumption of *Carausius morosus* (1924), *Tineola biselliella* (1926) and *Cimex lectularius* (1930) are extremely excellent. A long series of literature with regard to such problems was referred to his papers. Among these the study on the stick insect, *Carausius morosus*, is of interest for the present investigation. The following results derived from his elaborate work were based upon the observations of five individuals. The amount of food eaten by the insect became larger instar by instar, and that of the five examples were tabulated as follows.

Table 162. Foliage eaten by *Carausius morosus*
in different instars (unit in mm²) (After
TITSCHACK, 1924).

No. Instar	1	2	3	4	5
I	248.25	245.25	215.63	163.00	251.63
II	441.88	552.25	422.37	382.50	332.87
III	1112.87	1113.13	860.25	415.00	595.13
IV	1393.50	1376.12	1509.50	2005.25	2020.37
V	2364.00	2697.25	2615.75	2791.63	2967.88
VI	4266.75	4578.50	5908.00	5732.62	6069.25

The maximum record of the amount of food eaten by an insect (No. 4) during its life was 1078.4 cm² and 22.8 gr. of leaves. To produce 1 mgr. unit of the insect, nutrient of 4.0 mgr. was needed during the first 150 days and of 8.5 mg during the entire life. The ratio of the amount of food eaten per day in each instar to the body weight was calculated, giving the following values. First instar—27.7~29.0 %, second instar—19.2~19.9 %, third instar—15.5~17.5 %, fourth instar—15.3~17.6 %, fifth instar—14.6 %, sixth instar—11.5 %, adult stage—10.4 %. The fact would be explained by the relative decrease in diameter of the intestine of the insect during post-embryonic developmental period. The maximum amount of food eaten by an insect during the entire life was 18.6 times as much as the body weight. To produce 1 mgr. weight of eggs 7.8~10.4 mgr. of nutrient is necessary. Of the 100 units of food eaten by the insect 35.8 are excreted as excrement.

In order to make the present discussions easy, the present experiments fertile for investigation of insect nutrition, and the conclusion to be derived useful in economic entomology, it may be of some advantages to consider the general feature of the feeding habits of the insect and the nature of the food plants used in my experiments.

The physiological conditions represented by various environments differ greatly even within a single plant, and the nutritive value of the different parts of the leaf may vary greatly. Further the nutrients within the leaves varies from one time of day to another, depending upon the higher or lower contents of protein as shown in the extensive works done upon the nutrition of silkworms. It seems possible, therefore, that the nutritive value of the leaves of three different plants used, viz. *Lyonia Neziki*, *Prunus subhirtella* and *Amelanchier asiatica*, should vary very much not only in the different parts within the leaves but also in time of the day. In this connection it must be noted that the plants used in my experiments are not the "apparent" food but "actual" food for this insect (UVAROV, 1928). Nevertheless the stick insect, being strictly herbivorous according to the categories of HANDLIRSCH (1926), as in many cases of phytophagous insects, feeds upon any parts of leaves at any time. Actually the insects feed independently of the nutritive value of the leaves, as shown

in the organic matter contents, water contents, etc. in different plants or at different time. It is often experimentally demonstrated in certain groups of insects that when insects reared in isolation are compared with others from the same litter which have been reared in groups, a longer time elapses before the isolated insects accomplish equivalent moults and the longer stadia of the isolated insects delay the attainment of maturity. There seems to be no doubt that this slower growth of isolated insects may be ascribed to the absence of jostling and mutual stimulation. FAURE (1932) and others have noted differences between migratory locusts reared under crowded conditions and those reared in isolation. In FAURE's experiments the increased activity gave rise to structural and colorational differences. For instance, locusts of the phase *solitaria*, if taken off the veld early enough in their development as hoppers and crowded together in cages, would acquire the coloration of the phase *gregaria* before they reached the final moult. PETTIT (1940) reared *Blattella germanica* in similar conditions and recorded that such differences as structural and colorational have not been detected, the altered metabolism, under conditions of crowding and resulting stimulation, appeared merely to affect the time required to reach maturity, and such differences in growth rate were detectable at the temperature of 23° to 25°C, but were less noticeable as the temperature increased, because the duration of the nymphal period and the differences in rate were similarly reduced. In the present experiments, the material was all reared in isolation, and the results showed that the colour and structure of the stick insects were not at all influenced by the isolated condition in comparison with those reared in crowded condition. The total amount of food taken by each individual in a rearing box should express the value almost equal to that of an insect in the field, as the stick insect is exclusively solitary in habit. Moreover, the total length of the post-embryonic growth period in each experimental insect showed a very close value to the mean taken from a number of individuals. Thus all of the above mentioned conditions of the material are ideal enough as to regard the results before me to be most accurate and satisfactory in determining the total amount of food eaten by the insects for the completion of the post-embryonic growth, the maintenance of their metabolism and for the continuation of the reproduction.

Attention may now be turned to the consideration of the amount of food eaten by the material used in my experiments. In the following discussions some particular expressions are used as below:

1. Insect fed three times a day→Insect fed with 3A units of food a day, where A denotes one meal (unit).
2. Insect fed three times every other day→Insect fed with 3A units of food every other day.
3. Insect fed three times every third day→Insect fed with 3A units of food every third day.
4. Insect fed three times every fourth day→Insect fed with 3A units of food every fourth day.
5. Insect fed once a day→Insect fed with an A unit of food a day.

In other words, the experimental insects 1-5 as shown above were equivalent to those fed with 3A, 2A, 1.5A, 1.2A and 1A units of food every day respectively. However, we must not forget to remember the fact that 1.2 unit of food is actually of less value than 1A biologically, though theoretically larger, so far as the cases of No. 4 and 5 are concerned.

2. Number of Instars as a Criterion of Growth

Generally the stick insect, *Phraortes kumamotoensis*, moults six times in the female and five in the male, and this seems to be a universal rule of this insect. Thus the number of instars may be accepted as a criterion of the normal growth. Owing to the object of my rearing experiments, however, it is impossible to find examples showing any relation to this problem excepting the following unique case. Among many experimental material besides those not given in the present paper, I found a single male insect which underwent only four moults instead of five, characteristic of the species. The elimination of the fifth instar in this male may be ascribed to the unsatisfactory diet taken during the post-embryonic developmental period (fed once a day). The irregularity of the number of instars under the same environmental conditions is a well-known phenomenon among many species of insects, and in such cases the number of instars is not altogether a perfect criterion of the biologic age. For instance (HONGE

IV, 1933], *Melanoplus differentialis* usually passes six instars; but 13 of the insects used in nutritional experiments exhibited an extra instar apiece, making their total seven instead of six, and two males moulted eight times each. Of these insects exhibiting extra instars, 6 were males, consisting of 2 on the mixed diet, 2 on rye, 1 on barley, and 1 on wheat. The other 7 were females; of which 2 on the mixed diet, 1 on barley, 1 on lettuce, and 3 on wheat.

3. Length of Instars as a Criterion of Growth

It is well known that temperature, food, and other environmental factors affect the length of instars. In my material the effect of insufficient diet upon the length of instars was exceedingly evident. In feeding experiments of 2A units of food consumption per day, the length of the instars was strongly lengthened in comparison with those fed normally. In feeding experiments of 1.5A units of food consumption per day, the duration of the instars was very much influenced and much more lengthened than that of normally fed individuals, and sometimes the insects could not undergo the next moult. Feeding of 1.2A unit of food per day strongly affected the growth of insects and no insects could not only undergo the next moult but also maintain their metabolism. The effect of feeding of exactly 1A of food per day upon the duration of the instars was almost similar to that of the experiments classes 3 and 4; the length of the instars was very much lengthened or sometimes the insects could not undergo the next moult. Feeding of 2A, 1.5A, 1.2A or 1A seems to indicate that such a quantity of food was insufficient to initiate the activity or to obtain the necessary amount of moulting hormone regularly. Thus feeding of 3A units of food per day regularly would satisfy the requirement of the sufficient diet for this insect to complete the normal post-embryonic developmental period.

4. Increase in Weight in each Instar as a Criterion of Growth

In feeding experiments, increase or decrease in weight of the insects may afford a very recommendable criterion, and it is not

less important than the length of the instars. In all cases of my respective experiments of feeding of 2A, 1.5A or 1A, the material secured the dry weight of their mesothorax exclusively small in comparison with that of those fed normally. Thus it may be clear that each of feeding of 2A, 1.5A or 1A unit of food per day is insufficient for the insects to complete the normal post-embryonic developmental growth.

5. Linear Growth in each Instar as a Criterion of Growth

In feeding experiments, the linear growth of the insects in each instar may become a fairly good criterion of growth. In feeding experiments of 2A units of food per day, the length of the mesothorax was not apparently influenced by the insufficient diet. In feeding experiments of 1.5A unit of food per day, the length of the mesothorax was strikingly influenced by the insufficient diet and became shorter than that of normally fed individuals. In feeding experiments of 1A unit of food per day, the length of the mesothorax was either shorter than or as long as that of normally fed individuals. In other words, the influence of unsatisfactory diet was either evident or indistinct.

6. Necessary Amount of Food for the Completion of the Normal Post-embryonic Growth

As determined in my feeding experiments, 3A units of food per day may be regarded as the necessary and optimum amount of food for the insects to complete the normal post-embryonic developmental period. The total amount of food eaten by an individual insect during its larval instars was 8024.5 mm³ (7299.1~9101.5 mm³) in volume in the female and 4536.5 mm³ (3969.5~5350.9 mm³) in volume in the male. The total amount of organic matter eaten by an individual insect during its larval period was 65.59 gr. (61.68~69.50 gr.) in weight in the female and 31.76 gr. (30.17~33.14 gr.) in weight in the male. Comparisons of food quantity eaten in each larval instar with that in another made by several authors mentioned above were all carried out by a super-

ficial method, measuring only the total area of the leaves eaten. Even if the results derived from experiments by such a simple method and those obtained by my elaborate method are not much different in some cases, it appears that the method to show the quantity of food only by the area of leaves consumed is not accurate enough. In my column of experiments the amount of food (volume, organic matter and water) taken by the insects during their larval period was compared carefully with the weight of the mesothorax (exoskeleton) of the adult after the last moult. Thus the amount of food components to produce unit weight of the mesothorax of the adult was calculated separately in each instar. Since the insects used in the present investigation were selected at random, and further, I observed the food consumption of each individual separately by using the careful method, it seems probable that the results may represent the general features exhibited by phytophagous Orthoptera, including the Phasmidae and other related groups. The result was an astonishingly simple one, showing that the total amount of food eaten in each instar was doubled in the following one. The law may be expressed in the form of an equation: $V_n = 2^{n-1} V_1$, where V_n is the quantity of food taken in the stadium n , and V_1 is the same taken in the first stadium. Although this result resembles the so-called PRZIBRAM's principle for the growth process among the insect world in some respects, my law concerning the food requirement of the larval insects of Orthoptera has not been derived from, or has no direct relation with, the principle of PRZIBRAM, which is even not universally applicable to the increase in weight or in length of insects. Further it must be noted that the amount of food taken by the male in its larval period was approximately 50 per cent of that by the female in its larval period.

7. Necessary Amount of Food for Reproduction

The nutrients consumed by the female insect may apparently partly for the maintenance of metabolism and partly for the source of the development of the ovaries. The development of the ovaries is not entirely dependent upon the nutrient, but there is an evident, close correlation between the amount of food eaten and the forma-

tion of eggs. The feeding experiments of 2A, 1A and 1.5A units of food per day were carried out to determine the necessary and optimum amount of food for the continuation of reproduction. The results obtained indicated that 3A units of food per day were essentially necessary for a female insect to continue the normal and ideal oviposition during her life. According to the feeding experiments of 2A, 1A and 1.5A units of food per day, the relation between the food consumption and the oviposition could not be exclusively expressed by measuring the length of the preoviposition period. On the other hand the eggs produced by females fed with such units of food were all deformed and very few in number. From the observation given in detail in my previous paper (YASUMATSU, 1931), it is not difficult to understand the impossibility of hatching of larvae from these eggs. Thus it is evident that 2A, 1.5A and 1A unit of food may be insufficient for the female to continue the normal reproduction. At the same time this evidence would indicate that the reproduction is not exclusively due to the nutrition, but is influenced by many other factors. Next, it is of great interest that the amount of food taken by the adult insects (both sexes) decreases at the rate of about 12.3 per cent with successive periods of twenty days, and this phenomenon implies that the absolute quantity of 3A for each period decreases successively, taking the figures of $3A_1$, $2.6A_1$, $2.3A_1$, $2.0A_1$, $1.8A_1$, $1.6A_1$, $1.4A_1$ and $1.2A_1$ in successive periods, where A_1 means the absolute quantity of 3A in the first period of adult life. Though such figures as $2.0A_1$, $1.8A_1$, $1.6A_1$, $1.4A_1$ and $1.2A_1$ per day are biologically different from those of the same notations for those fed every other day, every third day, etc., this phenomenon seems to indicate the fact that the female insects are apt to deposit irregularly shaped eggs at the later period of their lives. The amount of food eaten per day by a female during the preoviposition period is about 3.7 times as much as that by a male during the first period after the final moult. That of the female during the first period is about 4 times as much as that of the male during the same period. In the second period that of the female is about 3.3 times as much as that of the male. In the third period that of the female is about 5.2 times as much as that of the male. In the fourth period that of the female is about 4.8 times as much as that of the male. In

the fifth period that of the female is about 4.7 times as much as that of the male. In the sixth period that of the female is about 3.4 times as much as that of the male. In the seventh period that of the female is about 2.5 times as much as of the male. The amount of food eaten per day by the female during the sixth period may be comparable to, or is almost equivalent to, that of the male during the second period, and that of the female during the seventh period is almost equivalent to that of the male during the third period. The average of the total cases of both sexes demonstrates that the amount of food eaten per day by the female is about 4 times as much as that of the male. On the other hand the amount of food eaten per day or per instar by the female is as much as that by the male during the larval stages. These facts contrast sharply with each other and are considered a strongly affirmative evidence for the existence of the distinct physiological differences between the sexes in the adult stage.

7. Attempt at the Application of the Results to the Practical Cases

It is desirable to apply the results obtained to the practical cases in economic entomology. Generally speaking, defoliating or phytophagous insects of mandibulate type may be classified into three different categories, according to their habits. Some species, called "leaf miners", feed upon the succulent interior leaf tissues while tunneling between the upper and lower cuticula. Others, "skeletonisers", eat all of the leaf except the vascular portions, thus skeletonising the leaf, leaving only the veins. Insects of the third category, "leaf chewers", eat all the leaf tissues. Almost all members of Orthoptera are skeletonisers during earlier parts of their developmental period and become leaf chewers during later stages. Regardless of the manner of their works, all of the defoliators have essentially the same effect upon the life process of the plant. The severity of the injury or damage is directly proportional to the amount of chlorophyll-bearing tissues destroyed. In accordance with the observations before us, it may be defined without difficulties that the damage caused by such defoliators as the larvae of sawflies, beetles as well as of butterflies and moths

(all are the holometabolous type of the insects) is essentially larger and stronger than that caused by the larvae of the Orthopterous defoliators (paurometabolous type of the insects). In the latter case, in which the adult insects are of the same feeding habit as the larvae, the injury caused by the female insect is always heavier than that of the male insect. In the Order Orthoptera the most famous and enormous is the damage caused by the migratory locusts. The damage caused by the Phasmidae is generally not severe and scatteredly observed throughout the world. But in Pagan Island, the Mariannas, Micronesia, the plantation of *Cocos nucifera* has been heavily damaged by a Phasmid, *Acanthograeffea denticulata*, in recent years. In the spring of 1940 I have had a good opportunity to visit the island and observed the injury. The damage was astonishingly severe, and in some places all the leaves were skeletonised completely by this large Phasmid. On a single coconut tree I was able to find no less than sixty or seventy individuals. Thus the economic loss due to this stick insect seemed to be comparable to that of an injurious Hispid beetle, *Planispa mariana* SPAETH, in Micronesia. But in all cases accurate estimate of economic loss due to such injurious insects is very difficult, and no recommendable methods of such estimations upon definite scientific basis have been established so far, though various methods were proposed. In some cases the estimations become too high, while in other occasions they are too low. It must be, therefore, very necessary to find some bases for the estimation of economic loss. The so-called damage is not a simple phenomenon but a total result of many factors. The damage caused by defoliators may be divided into two parts, i.e. the mechanical and the physiological. The mechanical damage represents the amount of the leaves eaten directly by injurious insects and may be measured comparatively easily. The physiological damage may be said as the after-effect of the mechanical damage due to injurious insects, and its measurements are much more difficult than that of the former. In the phytophagous Orthopterous insects, especially in the Phasmidae, the mechanical damage will be calculated or estimated by the application of the law derived from my feeding experiments. If we admit the definition of the mechanical damage as mentioned above, in which the damage is expressed by the amount of food taken,

we shall have $D_n = 2^{n-1} D_1$, where D_n denotes the damage caused in the instar n , and D_1 is the damage caused in the first instar. By using this equation we can state the following suppositions. The mechanical damage caused in the sixth instar is 32 times as heavy as that of the same number of insects in the first instar. The mechanical damage caused in the fifth instar is 16 times as heavy as that of the first. The same caused in the fourth instar is 8 times as heavy as that of the first. The same caused in the third instar is 4 times as severe as that of the first. The same caused in the second is twice as heavy as that of the first. In the adult stage the mechanical damage has the tendency of decreasing towards the end of life at a certain definite rate. The mechanical damage caused by the adult female per day in the preoviposition period is almost as severe as, or slightly more than, the damage caused in the third larval stadium. The mechanical damage caused by the adult male per day in the first period is as severe as that of the first larval instar and about one-fourth or one-fifth the damage by the adult female per day in the preoviposition period. The damage caused by the adult female in the preoviposition period is always heavier than that of the last larval stage and almost as heavy as that caused in the first period is always lighter than that of the preadult instar. Thus the damage seems to be heaviest in the last larval stage in the male insect and in the preoviposition period in the female insect. If we calculate the population of the injurious insect in a given area and apply the law of the mechanical damage given above to the result, we can estimate the actual mechanical damage occurred or occurring at a given time in a given area, and moreover the amount of possible loss in the future time.

E. Summary

1. The growth of larvae and the oviposition of the females of *Phraortes kumamotoensis* were investigated with regard to the food consumption.
2. The following plants were proved to be adequate food for complete development and metamorphosis of *Phraortes kumamotoensis*. *Rosa multiflora*, *Prunus Persica*, *Prunus subhirtella*,

Amelanchier asiatica (Rosaceae); *Lespedeza bicolor* (Papilionaceae); *Viburnum japonicum* (Caprifoliaceae); *Lyonia Neziki* (Ericaceae); *Celastrus articulatus* (Celastraceae); *Castanea crenata* (Fagaceae).

3. The time of feeding in one day is independent of the chemical change of fluid in the leaves of the plants.
4. In general the insects feeds three or four times a day.
5. In the experiments special attentions were concentrated into such physiological properties of the leaves eaten by insects as the thickness, the live weight, the dry weight, the water contents, the organic matter contents as well as the ash contents per unit volume. Three physiologically different types of plants of two different families were used in rearing the material for satisfactory comparisons.
6. In a normal and ideal development, a general trend, indicating a similarity in food consumption, is to be noted in all individuals reared with different plants. Thus under standardised conditions, the relation of food consumption with age is best defined by the formula $V_n = 2^{n-1} V_1$ for both sexes, where V_n is either the volume of food or the contents of organic matter consumed in the stadium n , and V_1 is either the volume of food or the contents of organic matter consumed in the first instar.
7. The actual amount of organic matter eaten by insects during the post-embryonic developmental period to produce the unit weight (1 gram) of the mesothorax of the adult was calculated, an average for several individuals showed the following values: 2.12~2.76 grams in the first instar, 4.52~6.06 in the second instar, 8.62~8.65 in the third instar, 14.91~15.89 in the fourth instar, 31.51~36.14 in the fifth instar and 67.53 in the sixth instar.
8. The actual amount of organic matter eaten by a female insect during the larval stadia was about twice as much as that by the male insect.
9. The experiments indicate the existence of the fundamental differences in the requirement of nourishment between the sexes. In connection with this fact it may be reasonable that the duration of the fifth instar was already slightly lengthened in the female sex as compared with that in the male.

10. The feeding on every other day affects the normal growth both in the duration of larval life and the dry weight of the mesothorax. The duration of the instars is strongly lengthened, and the dry weight of the mesothorax becomes exclusively lighter than that of the normally fed individuals.
11. The feeding of three times every third day or even every second day affects the normal growth very much. The duration of larval life is highly influenced and very much lengthened, or sometimes the insects cannot undergo the moulting and die. In this experiment the length of the mesothorax was also extremely influenced besides the weight.
12. The feeding of three times every fourth day causes the fatal influence upon the insects. No individuals can undergo the moulting. In this connection it is interesting to note that the insects which were obliged to remain hungry over two days could not respond quickly to food unless they drank water.
13. The feeding of once a day is also insufficient to complete the normal development. The duration of larval life is strongly lengthened, and the dry weight of the mesothorax becomes lighter than that of the normally fed individuals.
14. In the experiments with regard to the relation between the food consumption and the oviposition, special attention was made upon the external morphology of the eggs. In general the egg with a normal capitulum is the most predominant form occupying 68 per cent, the egg with a moderately deformed capitulum takes the value 13 per cent, and the egg with a strongly deformed capitulum or without capitulum occupies 19 per cent. The form of the capitulum or the absence of the capitulum is independent of the growth of the embryo within the egg, if the egg has been laid by a sound female. In general the eggs with a deformed capitulum are deposited by ill-fed females. The shape of the capsule has close connection with the hatching of the embryo.
15. It is apparent that the relation between the food consumption and the oviposition cannot be exclusively expressed by measuring the length of the preoviposition period.
16. The insufficient nutrition (fed three times every other day, fed once a day, or fed three times every third day) arrests the normal development of the female genital organs, especial-

ly of ovaries, from the continuous production of eggs during her life. It is also in close connection with the relatively shorter duration of life in the adult stage. The average number of eggs produced per day by the experimental insects with insufficient nutrition was prominently small without any exceptions, and the total number of eggs produced by them was about one half of that deposited by normal insects.

17. The percentage of the eggs with a normal capitulum produced by insects with insufficient nutrition was always lower than that of normal individuals, and the same of the eggs with a moderately deformed capitulum was always higher than that of normal ones. It is evident that the insufficient diet taken during the oviposition period exhibits a great influence on the inhibition in producing perfect eggs.
18. The egg with a deformed capsule has always a deformed capitulum. Thus the shape of the capsule becomes a good criterion in determining the adequate amount of food to produce perfect eggs. The variation in the shape of eggs deposited by insects fed on insufficient diet is very much larger than that of normal individuals.
19. In all cases the shape of eggs dropped by ill-fed insects was independent of the age of the insects.
20. After the preoviposition period the amount of food eaten by the insects has the tendency of decreasing towards the end of life. This means that the longer the life of the adult, the fewer is the average amount of food consumed per day. The amount of food consumed by the adult insects decreased at the rate of about 12.3 per cent with successive periods, each consisting of 20 days.
21. The amount of food eaten per day by a female in the preoviposition period is almost equal to, or slightly larger than, the total amount of food taken in the third instar or her life, and distinctly smaller than the same of the fourth one. In the male the amount of food consumed per day in its first period of adult life is almost equal to the total amount of food eaten in the first stadium of his larval life and is about one-fourth or one-fifth the average amount of food consumed per day during the preoviposition period of the female.

22. The feeding of three times a day would represent the satisfactory and sufficient diet for this insect to complete the normal post-embryonic developmental period. The feeding of less amount of diet per day seems to be insufficient to initiate the activity or to obtain the necessary amount of moulting hormone regularly.
23. The amount of food eaten per day by an adult female is about 4 times as much as that of the male. This fact contrasts sharply with that seen during the post-embryonic developmental period up to the fifth instar in both sexes and is a strong, affirmative evidence for the existence of the distinct physiological differences between the sexes in adult stage. In the larval period the amount of food eaten per day or per instar by a female is as much as that of the male up to the fifth instar.
24. The value $\sum V$ in the preoviposition period of the female is always larger than that of the last larval stage and approximately equal to the value of $\sum V_5$ and $\sum V_6$ taken together. From this fact it is clear that an extremely larger amount of food is necessary for the female during the preoviposition period and it contrasts sharply with the amount consumed by the male during the first period of twenty days in adult life. In the male sex the value $\sum V$ in the first period immediately after the last ecdysis is smaller than that in the last larval stage.
25. *Phraortes kumamotoensis* moults six times in the female and five in the male, and this may be regarded as a universal rule in this insect. This character seems to be unaffected by the effect of an unsatisfactory diet taken during the larval stadia. Only a single exception was found among hundreds of rearing experiments. This male insect (fed once a day) underwent only four moults instead of five, characteristic of the species.
26. In the case of injurious insects of the order Orthoptera, we may be able to estimate the actual mechanical damages occurred or occurring at a given time and in a given area, as well as the amount of possible loss in the future in application of the law of mechanical damage here proposed, $D_n = 2^{n-1} D_1$, where D_n denotes the damage caused in the instar, n and D_1 is the damage caused in the first instar.

VII. GENERAL RÉSUMÉ

1. The growth of larvae of *Phraortes kumamotoensis* was analysed with regard to the length, regeneration, weight and the food consumption experimentally in full detail.
2. The previous works relating to the problem in question were reviewed.
3. The growth rate both in length and weight, and further the amount of food consumption must be correlated with one another in the larval stadia.
4. The interpretation of the linear growth of the appendages in insects can be safely undertaken by the idea of the growth-promoting and growth-inhibiting factors analysed in my experiments.
5. To decide the existence or absence of two or more growth phases is the primary and fundamental process in the study of the growth in insects. Bearing this fact in mind it is enabled to select suitable organs for the comparison of the growth, to derive the equation of the growth curve, if needed, and to calculate the growth coefficient or growth constant, if present, from the data accumulated by the experiments.
6. The mode of change in the amount of food eaten by insects during their larval period may be classified into several types in terms of their increasing or decreasing rate.
7. *Phraortes kumamotoensis* is a representative of one type in which the amount of food eaten in successive instars follows fairly well after the fashion of a geometrical progression whose exponent is 2 and differs entirely from that of the Lepidopterous insects.
8. For the estimation of losses by injurious insects a part of answers can be given by determining the type of the larval development of the insects in question.
9. The results of the present study would throw some light upon the future investigation of the growth of injurious or non-injurious insects.

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